NASA Technical Memorandum 101057

Performance and Loads Data from an Outdoor Hover Test of a Lynx Tail Rotor

David B. Signor, Gloria K. Yamauchi,
Charles A. Smith, and Martin J. Hagen

June 1989

National Aeronautics and
Space Administration

NASA Technical Memorandum 101057

Performance and Loads Data from an Outdoor Hover Test of a Lynx Tail Rotor

David B. Signor, Gloria K. Yamauchi, and Charles A. Smith,
Ames Research Center, Moffett Field, California
Martin J. Hagen,
DeAnza College, Cupertino, California

June 1989

National Aeronautics and
Space Administration

Ames Research Center
Moffett Field, California 94035

CONTENTS

PERFORMANCE AND LOADS DATA FROM AN OUTDOOR HOVER TEST OF A LYNX TAIL ROTOR

David B. Signor, Gloria K. Yamauchi, and Charles A. Smith
NASA Ames Research Center

and

Martin J. Hagen
De Anza College

SUMMARY

A Lynx tail rotor was tested in hover at the Outdoor Aerodynamic Research Facility at NASA Ames Research Center. The test objectives were (1) to measure the isolated rotor performance to provide a baseline for subsequent testing, and (2) to operate the rotor throughout the speed and collective envelope before testing in the NFAC 40- by 80-Foot Wind Tunnel. Rotor forces and blade bending moments were measured at ambient wind conditions from zero to 6.23 m/sec. The test envelope was limited to rotor speeds of 1550 to 1850 rpm and –13° to +20° of blade collective pitch. The isolated rotor performance and blade loads data are presented.

INTRODUCTION

The main objective of this test was to document the isolated hover performance and loads of an isolated Lynx tail rotor. The data will be used in future investigations of full-scale main-rotor/tail-rotor interaction in both hover and forward flight. The secondary objective of this test was to check the operation of the rotor throughout its speed and collective envelope before testing in the National Full-Scale Aerodynamics Research Complex (NFAC) 40- by 80-Foot Wind Tunnel.

Before this test, the Lynx tail rotor was tested in the Royal Aircraft Establishment 24-Foot Wind Tunnel, where isolated tail-rotor acoustic data in forward flight were obtained (ref. 1). The tail rotor and associated hardware (hub, drive shaft, and right-angle gearbox) were then brought to NASA Ames Research Center. The rotor and hardware were mounted on a three-axis traversing mechanism known as the Tail Rotor Test Rig (TRTR). Figure 1 shows the Lynx tail rotor mounted on the TRTR at the Outdoor Aerodynamic Research Facility (OARF) at Ames.

SYMBOLS

A	rotor disk area, πR^2, m^2
a	speed of sound, m/sec
c	blade chord, m
C_Q	rotor torque coefficient
C_T	rotor thrust coefficient
FM	rotor figure of merit
H	rotor in-plane force, N
M_{tip}	rotor tip Mach number, V_{tip}/a
q	dynamic pressure, $\rho V^2/2$, N/m^2
Q_B	balance torque, N-m
Q_R	rotor torque, N-m
R	rotor radius, m
r	blade radial station, m
s	rotor solidity, $4cR/A$
V	rotor inflow velocity, m/sec
V_{tip}	rotor tip speed, ΩR, m/sec
T	rotor thrust, N
ρ	air density, kg/m^3
Ω	rotor rotation speed, rad/sec

TAIL ROTOR AND TAIL ROTOR TEST RIG

Lynx Tail Rotor

Hub– The hub has conventional flapping and feathering hinges, and incorporates torsionally flexible tiebars which carry the centrifugal loads inboard to the flapping hinges. As is usual for tail rotors, there is a collective pitch control but no cyclic pitch control. The hub has free flapping hinges with a linkage giving a 1:1 relationship between flapping angle and incremental blade pitch angle; thus an increase in flapping angle reduces the pitch angle.

Blades– The Lynx tail rotor consists of four constant-chord blades. The blade parameters are shown in figure 2. The blade profile is an NPL 9615, which is similar to a NACA 0012 section with a drooped leading edge. Additional details about this blade profile are given in reference 2. Each blade has a light alloy spar, machined integrally with the root attachment, which forms the nose portion of the airfoil section. There is a flush-fitting stainless steel sheath on the leading edge. The rear section of each blade has a bonded skin stabilized by a Nomex Plastics honeycomb core. Each blade is attached to the hub by the outboard tiebar pin and a six-bolt, root-end flanged joint.

Tail Rotor Test Rig

The TRTR was designed to test full-scale tail rotors in the 40- by 80-Foot Wind Tunnel at Ames. Rotors with a maximum diameter of 2.4 m and a maximum rotor thrust of 6227 N can be tested using the TRTR.

The TRTR is shown schematically in figure 3. The rotor drive motor, drive shaft, and right-angle gearbox are mounted inside the horizontal boom, which is mounted on the main vertical support. The rotor extends out from the forward end of the horizontal boom by means of the gearbox. The vertical position of the rotor is varied by raising or lowering the entire horizontal boom on the vertical support, which rests on a traversing bed, as shown in figures 1 and 3. The TRTR can traverse 3.7 m vertically, 3 m longitudinally, and 1.8 m laterally.

The drive motor is a 186-kW, 4-pole, 120-Hz electric motor with a maximum speed of 3600 rpm. The drive shaft consists of two lengths of drive shaft obtained from a Lynx tail rotor assembly. The gearbox is a standard Lynx right-angle gearbox. At the end of the drive shaft is a stiffened steel tube, 168 mm in diameter, with a four-bar strain gauge balance interposed between the top of the tube and the gearbox mounting bracket. The horizontal pod fairing was not used during testing (see figs. 1 and 3). The rotor collective was manually set before each run by means of a threaded lever arm, and was not adjustable during rotor operation.

The right-angle gearbox has a reduction ratio of 1.95:1. Although the gearbox is normally operated at positive thrust, brief runs at maximum negative thrust (4448 N) are allowable. Negative thrust produces a more severe loading of the gearbox.

During this test, the gearbox was operated in an inverted position relative to its normal flight configuration.

MEASUREMENT INSTRUMENTATION

Performance

A strain gauge balance is mounted between the horizontal support tube and the gearbox mounting bracket. The rotor shaft is 0.26 m lateral to the midpoint of the balance. There are seven four-bar strain gauge bridges mounted on the balance. The orientation of loads computed from the balance gauges are shown in figure 4. Vertical force is measured directly from the H gauge. Positive vertical force is upward. Rotor torque is given by Q_B-0.2515H (allowing for the rotor shaft being 0.2515 m above the Q_B-gauge axis). Torque is Q_B+0.2515H for the reversed-thrust configuration. Positive torque is measured when power is input to the rotor. Rotor thrust is measured directly from the T gauge. Positive thrust is defined as toward the gearbox.

The balance was calibrated by applying known vertical, thrust (positive and negative), and torque loads at the rotor center. Single and combined load conditions were applied to increase the accuracy of the calibration.

Interaction between the thrust and torque gauges was accounted for in the data-reduction equations. The accuracy of the balance was estimated by dividing the average difference between the calculated and applied load by the maximum load capacity of the balance (maximum thrust = ±4448 N; maximum torque = 790 N·m). Calibration data from the combined load conditions were used to compute the balance accuracy. As shown in table I, loading in the negative-thrust direction produces a larger error than loading in the positive-thrust direction.

Rotor torque and rotor thrust coefficients, in addition to figure of merit, were calculated from the measured balance loads as follows:

$$C_Q = Q_R/\rho AR(V_{tip})^2 \tag{1}$$

$$C_T = T/\rho A(V_{tip})^2 \tag{2}$$

$$FM = C_T^{3/2}/\sqrt{2}\, C_Q \tag{3}$$

Blade Loads

One of the four rotor blades was instrumented to measure blade bending moments. Chordwise bending was measured at the 30% radial station, and flapwise bending was measured at the 30%, 40%, and 70% radial stations. Also, a strain gauge was installed at the root of one blade to measure flap angle.

Ambient Wind

Ambient windspeed and direction were measured using a cup anemometer and a weather vane positioned on a tower at a height of 10 m. The tower was 46 m upstream of the rotor and 55 m from the rotor axis.

DATA PRESENTATION

Rotor performance and blade loads data were acquired for several test configurations. Only the data obtained during the isolated tail rotor configuration (Runs 27-48), however, are presented in this report. The rotor was positioned 6.1 m above the ground during all data acquisition. The maximum rotor rpm was 1850. In general, data were acquired at four tip Mach numbers for each collective setting. The average windspeed was generally less than 1.5 m/sec. Repeat runs were necessary to determine wind effects on the data.

The test conditions for each of the isolated tail rotor runs are presented in table II. Vector plots of windspeed and direction (relative to the rotor axis) are shown in figures 5-10. The vectors point in the direction from which the ambient wind approached the rotor. Vector components of ambient wind velocity parallel and perpendicular to the rotor axis are tabulated in appendix A. The calculated induced axial velocity is also presented for comparison with the wind velocity component parallel to the rotor axis.

Mean blade bending moment data were acquired at three radial locations on one of the four Lynx blades (see figure 2). The chordwise bending moment at the 30% radial location as a function of rotor torque for $M_{tip} = 0.52$ and 0.62 is presented in figure 11. The flapwise bending moments at the 30%, 40%, and 70% radial stations, as a function of rotor thrust, are shown in figures 12, 13, and 14, respectively.

Figures 11-14 include data for windspeeds ranging from nearly zero to approximately 6.23 m/sec. There was no noticeable effect of windspeed on the blade bending moments.

Rotor thrust variation with collective pitch for $M_{tip} = 0.52$ and 0.62 is shown in figure 15. Rotor FM and C_Q/s, as a function of C_T/s for $M_{tip} = 0.52$ and 0.62, are shown in figures 16 and 17, respectively. There was no significant effect of windspeed on M_{tip}. The blade loads and performance data presented in figures 11-17 are tabulated in appendix B for each of the isolated tail rotor runs.

APPENDIX A

AMBIENT WINDSPEED COMPONENTS AND INDUCED VELOCITIES FOR THE ISOLATED TAIL ROTOR CONFIGURATION

A self-explanatory header is given for each run, as well as the following tabulated data.[a]

Pt	:	data point number
V_{atm}	:	ambient windspeed (m/sec)
D_{atm}	:	ambient wind direction relative to the rotor inflow axis (deg)
Induced Wind	:	calculated induced velocity, $[\text{thrust}/(2\rho\pi R^2)]^{1/2}$, to be compared with V_{atm} parallel (m/sec)
Thrust	:	rotor thrust (N)
C_T/s	:	coefficient of thrust divided by rotor solidity
V_{atm} parallel	:	component of ambient wind in the direction of the rotor axis, positive toward 0° (m/sec)
V_{atm} perpend.	:	component of ambient wind in the direction of the rotor tip path plane, positive toward 90° (m/sec)
V_{avg}	:	$[V_{atm}\cdot par.^2 + V_{atm}\cdot per.^2)]^{1/2}$

Averages for each quantity are computed at the end of each run. The vector-averaged V_{atm} and D_{atm} shown also appear in table III.

[a]Note that values in tables marked Vatm, Datm, CT/s, Vavg, and Kg/m3 should be read as V_{atm}, D_{atm}, C_T/s, V_{avg}, and Kg/m^3.

Run 27 Collective = 15.0 Deg Air Density = 1.28 Kg/m^3

Pt	Vatm (m/s)	Datm (Deg)	Induced Wind (m/s)	Thrust (N)	CT/s	Vatm Parallel (m/s)	Vatm Perpend. (m/s)
4	1.45	67.55	15.45	2324.19	0.0758	0.55	1.34
5	1.24	75.39	15.45	2324.23	0.0756	0.31	1.20
6	1.81	60.26	16.53	2682.20	0.0750	0.90	1.57
7	1.45	48.89	16.48	2667.90	0.0746	0.95	1.09
8	1.88	39.98	17.65	3059.21	0.0744	1.44	1.21
9	1.98	17.52	17.62	3047.47	0.0742	1.89	0.60
10	2.18	23.97	18.56	3382.58	0.0746	1.99	0.89
11	1.88	24.32	18.56	3356.16	0.0746	1.71	0.77
12	1.97	25.23	18.56	3356.16	0.0746	1.78	0.84
Avg	1.76		17.21	2911.12	0.0748	1.28	1.06
Vavg	1.66	39.50					

Run 28 Collective = 9.0 Deg Air Density = 1.28 Kg/m^3

Pt	Vatm (m/s)	Datm (Deg)	Induced Wind (m/s)	Thrust (N)	CT/s	Vatm Parallel (m/s)	Vatm Perpend. (m/s)
3	1.45	0.51	10.62	1106.49	0.0359	1.45	0.01
4	1.36	0.90	10.56	1094.33	0.0356	1.36	0.02
5	1.49	40.04	11.34	1262.42	0.0353	1.14	0.96
6	1.62	41.76	11.30	1253.24	0.0350	1.21	1.08
7	1.87	41.27	12.09	1435.03	0.0349	1.41	1.23
8	2.32	40.23	12.02	1418.58	0.0345	1.77	1.50
9	2.55	39.42	12.51	1536.59	0.0340	1.97	1.62
10	2.37	36.28	12.55	1545.63	0.0342	1.91	1.40
Avg	1.88		11.62	1331.54	0.0349	1.53	0.98
Vavg	1.81	32.64					

Run 29 Collective = 4.0 Deg Air Density = 1.28 Kg/m^3

Pt	Vatm (m/s)	Datm (Deg)	Induced Wind (m/s)	Thrust (N)	CT/s	Vatm Parallel (m/s)	Vatm Perpend. (m/s)
3	2.53	358.73	5.17	261.98	0.0085	2.53	-0.06
4	2.47	359.86	5.17	261.98	0.0085	2.47	-0.01
5	2.67	347.97	5.63	311.52	0.0087	2.61	-0.56
6	2.52	336.17	5.73	322.26	0.0090	2.31	-1.02
7	2.63	336.11	6.27	386.07	0.0094	2.40	-1.07
8	2.61	331.67	6.34	394.28	0.0096	2.30	-1.24
9	2.33	321.14	6.62	430.29	0.0095	1.81	-1.46
10	2.66	320.52	6.66	435.29	0.0096	2.05	-1.69
Avg	2.55		5.95	350.46	0.0091	2.31	-0.89
Vavg	2.47	339.01					

Run 30 Collective = 0.0 Deg Air Density = 1.24 Kg/m^3

Pt	Vatm (m/s)	Datm (Deg)	Induced Wind (m/s)	Thrust (N)	CT/s	Vatm Parallel (m/s)	Vatm Perpend. (m/s)
3	1.81	77.30	1.33	16.94	0.0005	0.40	1.77
4	2.46	26.30	2.15	43.83	0.0010	2.21	1.09
5	6.23	15.19	-2.35	-52.60	-0.0012	6.01	1.63
6	5.69	19.85	-2.26	-47.98	-0.0011	5.35	1.93
7	5.92	10.65	-2.36	-52.34	-0.0012	5.82	1.09
Avg	4.42		-0.70	-18.43	-0.0004	3.96	1.50
Vavg	4.23	20.80					

Run 31 Collective = -13.0 Deg Air Density = 1.27 Kg/m^3

Pt	Vatm (m/s)	Datm (Deg)	Induced Wind (m/s)	Thrust (N)	CT/s	Vatm Parallel (m/s)	Vatm Perpend. (m/s)
6	1.50	263.66	-12.65	-1559.71	-0.0508	-0.17	-1.49
7	1.59	256.20	-12.62	-1550.50	-0.0505	-0.38	-1.54
8	1.58	247.13	-13.56	-1791.43	-0.0503	-0.61	-1.46
9	1.62	257.47	-13.59	-1798.55	-0.0505	-0.35	-1.58
10	1.35	249.24	-14.59	-2074.88	-0.0508	-0.48	-1.26
11	1.19	236.02	-14.60	-2076.57	-0.0509	-0.67	-0.99
Avg	1.47		-13.60	-1808.61	-0.0506	-0.44	-1.39
Vavg	1.46	252.31					

Run 32 Collective = -9.0 Deg Air Density = 1.27 Kg/m^3

Pt	Vatm (m/s)	Datm (Deg)	Induced Wind (m/s)	Thrust (N)	CT/s	Vatm Parallel (m/s)	Vatm Perpend. (m/s)
3	0.60	248.65	-9.63	-903.18	-0.0293	-0.22	-0.56
4	0.53	255.23	-9.64	-905.07	-0.0294	-0.14	-0.51
5	0.43	246.09	-10.37	-1048.37	-0.0294	-0.17	-0.39
6	0.50	233.29	-10.36	-1044.80	-0.0293	-0.30	-0.40
7	0.37	205.36	-11.15	-1211.77	-0.0296	-0.33	-0.16
8	0.52	190.65	-11.12	-1203.58	-0.0294	-0.51	-0.10
9	0.77	176.30	-11.49	-1286.64	-0.0294	-0.77	0.05
10	0.69	179.18	-11.47	-1282.26	-0.0293	-0.69	0.01
Avg	0.55		-10.65	-1110.71	-0.0294	-0.39	-0.26
Vavg	0.47	213.35					

Run 33 Collective = -5.0 Deg Air Density = 1.27 Kg/m^3

Pt	Vatm (m/s)	Datm (Deg)	Induced Wind (m/s)	Thrust (N)	CT/s	Vatm Parallel (m/s)	Vatm Perpend. (m/s)
3	0.16	228.86	-5.81	-328.96	-0.0107	-0.11	-0.12
4	0.19	195.19	-5.84	-332.03	-0.0108	-0.18	-0.05
5	-0.01	242.82	-6.31	-387.72	-0.0109	0.00	0.01
6	0.06	291.49	-6.30	-387.25	-0.0109	0.02	-0.06
7	-0.01	278.43	-6.77	-446.23	-0.0109	0.00	0.01
8	-0.01	278.37	-6.74	-442.13	-0.0108	0.00	0.01
9	-0.01	291.98	-7.14	-495.96	-0.0110	0.00	0.01
10	-0.01	323.96	-7.20	-504.98	-0.0112	-0.01	0.01
Avg	0.05		-6.51	-415.66	-0.0109	-0.03	-0.02
Vavg	0.04	213.36					

Run 34 Collective = -1.0 Deg Air Density = 1.27 Kg/m^3

Pt	Vatm (m/s)	Datm (Deg)	Induced Wind (m/s)	Thrust (N)	CT/s	Vatm Parallel (m/s)	Vatm Perpend. (m/s)
3	1.28	328.53	-1.48	-21.41	-0.0007	1.09	-0.67
4	1.29	323.83	-1.58	-24.46	-0.0008	1.04	-0.76
5	1.65	313.78	-1.60	-24.87	-0.0007	1.14	-1.19
6	1.78	310.22	-1.60	-24.87	-0.0007	1.15	-1.36
7	1.71	318.90	-1.83	-32.68	-0.0008	1.29	-1.12
8	1.72	315.08	-1.71	-28.59	-0.0007	1.22	-1.21
9	1.70	289.87	-0.96	-9.02	-0.0002	0.58	-1.60
10	1.59	297.78	-1.18	-13.53	-0.0003	0.74	-1.41
Avg	1.59		-1.49	-22.43	-0.0006	1.03	-1.17
Vavg	1.56	311.50					

Run 35 Collective = 0.0 Deg Air Density = 1.27 Kg/m^3

Pt	Vatm (m/s)	Datm (Deg)	Induced Wind (m/s)	Thrust (N)	CT/s	Vatm Parallel (m/s)	Vatm Perpend. (m/s)
4	1.77	294.37	1.78	30.70	0.0010	0.73	-1.61
5	1.76	294.34	1.68	27.60	0.0009	0.73	-1.60
6	1.79	293.56	1.81	31.97	0.0009	0.72	-1.64
7	1.78	294.05	1.81	31.97	0.0009	0.73	-1.63
8	1.71	299.07	1.71	28.39	0.0007	0.83	-1.49
9	1.76	303.64	1.59	24.48	0.0006	0.97	-1.47
10	2.09	309.60	1.36	18.03	0.0004	1.33	-1.61
11	1.95	307.34	1.52	22.54	0.0005	1.18	-1.55
Avg	1.83		1.66	26.96	0.0007	0.90	-1.58
Vavg	1.82	299.80					

Run 36 Collective = -3.0 Deg Air Density = 1.27 Kg/m^3

Pt	Vatm (m/s)	Datm (Deg)	Induced Wind (m/s)	Thrust (N)	CT/s	Vatm Parallel (m/s)	Vatm Perpend. (m/s)
3	1.14	261.94	-3.50	-119.58	-0.0039	-0.16	-1.13
4	0.78	266.28	-3.37	-110.38	-0.0036	-0.05	-0.78
5	0.43	241.07	-3.72	-135.17	-0.0038	-0.21	-0.38
6	1.39	131.94	-3.72	-135.17	-0.0038	-0.93	1.03
7	1.63	127.60	-3.83	-142.95	-0.0035	-0.99	1.29
8	1.47	140.14	-3.83	-142.95	-0.0035	-1.13	0.94
9	1.12	173.25	-4.02	-157.29	-0.0035	-1.11	0.13
10	0.69	228.21	-3.84	-143.81	-0.0032	-0.46	-0.51
Avg	1.08		-3.73	-135.91	-0.0036	-0.63	0.08
Vavg	0.63	173.20					

Run 37 Collective = 5.0 Deg Air Density = 1.27 Kg/m^3

Pt	Vatm (m/s)	Datm (Deg)	Induced Wind (m/s)	Thrust (N)	CT/s	Vatm Parallel (m/s)	Vatm Perpend. (m/s)
3	0.88	191.11	6.77	445.88	0.0142	-0.86	-0.17
4	0.84	179.15	6.58	422.31	0.0137	-0.84	0.01
5	1.16	169.14	7.06	484.96	0.0136	-1.14	0.22
6	1.37	174.77	6.90	463.56	0.0130	-1.36	0.12
7	1.05	182.91	7.36	528.16	0.0135	-1.05	-0.05
8	1.08	187.15	7.46	542.28	0.0134	-1.07	-0.13
9	1.10	191.79	8.05	631.92	0.0140	-1.08	-0.22
10	1.12	194.96	8.06	632.25	0.0141	-1.08	-0.29
Avg	1.08		7.28	518.92	0.0137	-1.06	-0.06
Vavg	1.06	183.47					

Run 38 Collective = 13.0 Deg Air Density = 1.22 Kg/m^3

Pt	Vatm (m/s)	Datm (Deg)	Induced Wind (m/s)	Thrust (N)	CT/s	Vatm Parallel (m/s)	Vatm Perpend. (m/s)
3	1.89	108.86	14.67	2014.84	0.0655	-0.61	1.79
4	1.65	98.40	14.65	2007.27	0.0650	-0.24	1.63
5	1.73	94.87	15.68	2300.21	0.0645	-0.15	1.72
6	1.39	100.21	15.80	2335.87	0.0655	-0.25	1.37
7	2.11	88.81	16.64	2592.32	0.0632	0.04	2.11
8	1.67	91.53	16.74	2621.04	0.0639	-0.04	1.67
9	1.95	111.04	17.51	2870.71	0.0645	-0.70	1.82
10	1.89	106.73	17.46	2851.54	0.0640	-0.54	1.81
Avg	1.78		16.14	2449.22	0.0645	-0.31	1.74
Vavg	1.77	100.14					

Run 39 Collective = 15.0 Deg Air Density = 1.27 Kg/m^3

Pt	Vatm (m/s)	Datm (Deg)	Induced Wind (m/s)	Thrust (N)	CT/s	Vatm Parallel (m/s)	Vatm Perpend. (m/s)
3	0.42	333.81	15.59	2367.12	0.0772	0.38	-0.19
4	0.62	325.06	15.58	2364.05	0.0771	0.51	-0.36
5	0.82	323.67	16.81	2752.86	0.0772	0.66	-0.49
6	0.86	320.26	16.79	2746.08	0.0772	0.66	-0.55
7	0.92	325.51	18.19	3221.84	0.0787	0.76	-0.52
8	0.90	316.02	18.19	3221.84	0.0787	0.65	-0.62
9	0.98	314.20	19.11	3557.40	0.0789	0.68	-0.70
10	0.93	319.23	19.11	3556.79	0.0788	0.70	-0.61
Avg	0.81		17.42	2973.50	0.0780	0.63	-0.50
Vavg	0.80	321.12					

Run 40 Collective = 7.0 Deg Air Density = 1.27 Kg/m^3

Pt	Vatm (m/s)	Datm (Deg)	Induced Wind (m/s)	Thrust (N)	CT/s	Vatm Parallel (m/s)	Vatm Perpend. (m/s)
3	1.83	317.32	8.78	751.14	0.0244	1.35	-1.24
4	1.82	314.92	8.78	751.14	0.0244	1.29	-1.29
5	1.48	310.06	9.51	881.86	0.0247	0.95	-1.13
6	1.48	310.38	9.50	878.29	0.0246	0.96	-1.13
7	1.45	304.10	10.19	1012.34	0.0247	0.81	-1.20
8	1.52	302.57	10.19	1012.34	0.0247	0.82	-1.28
9	1.69	300.82	10.70	1116.10	0.0247	0.87	-1.45
10	1.70	304.16	10.70	1116.10	0.0247	0.95	-1.41
Avg	1.62		9.80	939.91	0.0246	1.00	-1.27
Vavg	1.61	308.28					

Run 41 Collective = 13.0 Deg Air Density = 1.27 Kg/m^3

Pt	Vatm (m/s)	Datm (Deg)	Induced Wind (m/s)	Thrust (N)	CT/s	Vatm Parallel (m/s)	Vatm Perpend. (m/s)
3	1.67	265.18	14.43	2029.09	0.0660	-0.14	-1.66
4	1.82	259.31	14.25	1976.82	0.0643	-0.34	-1.79
5	1.69	264.14	15.32	2287.79	0.0640	-0.17	-1.68
6	1.67	267.80	15.26	2269.92	0.0635	-0.06	-1.67
7	1.54	264.50	16.50	2650.70	0.0646	-0.15	-1.53
8	1.52	269.94	16.42	2626.08	0.0640	0.00	-1.52
9	1.64	257.11	17.39	2946.15	0.0652	-0.37	-1.60
10	1.55	259.57	17.23	2893.27	0.0641	-0.28	-1.52
Avg	1.64		15.85	2459.98	0.0645	-0.19	-1.62
Vavg	1.63	263.36					

Run 42 Collective = 1.0 Deg Air Density = 1.27 Kg/m^3

Pt	Vatm (m/s)	Datm (Deg)	Induced Wind (m/s)	Thrust (N)	CT/s	Vatm Parallel (m/s)	Vatm Perpend. (m/s)
3	1.78	274.09	2.81	76.96	0.0025	0.13	-1.78
4	1.76	275.22	2.81	76.96	0.0025	0.16	-1.75
5	1.17	278.69	2.96	85.48	0.0024	0.18	-1.16
6	1.17	277.91	2.96	85.48	0.0024	0.16	-1.16
7	1.34	270.88	3.12	94.59	0.0023	0.02	-1.34
8	1.20	272.63	3.12	94.59	0.0023	0.06	-1.20
9	0.98	274.54	3.27	104.04	0.0023	0.08	-0.98
10	1.08	270.69	3.34	108.57	0.0024	0.01	-1.08
Avg	1.31		3.05	90.83	0.0024	0.10	-1.30
Vavg	1.31	274.33					

Run 43 Collective = 9.0 Deg Air Density = 1.27 Kg/m^3

Pt	Vatm (m/s)	Datm (Deg)	Induced Wind (m/s)	Thrust (N)	CT/s	Vatm Parallel (m/s)	Vatm Perpend. (m/s)
3	1.03	254.23	10.80	1135.88	0.0368	-0.28	-0.99
4	1.05	256.30	10.75	1126.62	0.0365	-0.25	-1.02
5	1.09	259.05	11.36	1257.21	0.0353	-0.21	-1.07
6	1.14	257.31	11.53	1294.78	0.0364	-0.25	-1.11
7	1.44	268.00	12.39	1494.25	0.0365	-0.05	-1.44
8	1.39	270.20	12.42	1502.43	0.0367	0.00	-1.39
9	1.48	265.15	12.96	1635.75	0.0362	-0.13	-1.47
10	1.51	268.81	12.99	1644.78	0.0364	-0.03	-1.51
Avg	1.27		11.90	1386.46	0.0364	-0.15	-1.25
Vavg	1.26	263.23					

Run 44 Collective = 11.0 Deg Air Density = 1.27 Kg/m^3

Pt	Vatm (m/s)	Datm (Deg)	Induced Wind (m/s)	Thrust (N)	CT/s	Vatm Parallel (m/s)	Vatm Perpend. (m/s)
3	0.24	270.46	12.57	1539.23	0.0500	0.00	-0.24
4	0.31	266.02	12.58	1542.31	0.0501	-0.02	-0.31
5	0.00	270.72	13.30	1724.44	0.0483	0.00	0.00
6	-0.01	270.62	13.39	1745.87	0.0489	0.00	0.01
7	0.06	26.85	14.44	2031.11	0.0495	0.05	0.03
8	0.18	105.11	14.38	2014.69	0.0491	-0.05	0.17
9	0.21	120.98	15.11	2225.25	0.0493	-0.11	0.18
10	0.18	134.40	15.11	2225.25	0.0493	-0.13	0.13
Avg	0.15		13.86	1881.02	0.0493	-0.03	0.00
Vavg	0.03	186.86					

Run 45 Collective = 5.0 Deg Air Density = 1.27 Kg/m^3

Pt	Vatm (m/s)	Datm (Deg)	Induced Wind (m/s)	Thrust (N)	CT/s	Vatm Parallel (m/s)	Vatm Perpend. (m/s)
3	0.91	166.09	6.49	410.87	0.0134	-0.88	0.22
4	0.89	166.06	6.37	395.54	0.0129	-0.86	0.21
5	1.31	166.67	6.85	456.43	0.0128	-1.27	0.30
6	1.59	166.09	7.16	499.22	0.0140	-1.54	0.38
7	1.55	159.38	7.44	539.76	0.0132	-1.45	0.55
8	1.51	154.98	7.69	581.11	0.0141	-1.37	0.64
9	1.40	153.32	7.93	617.34	0.0136	-1.25	0.63
10	1.38	154.75	7.94	619.37	0.0136	-1.25	0.59
Avg	1.32		7.23	514.96	0.0135	-1.24	0.44
Vavg	1.31	160.40					

Run 46 Collective = 13.0 Deg Air Density = 1.27 Kg/m^3

Pt	Vatm (m/s)	Datm (Deg)	Induced Wind (m/s)	Thrust (N)	CT/s	Vatm Parallel (m/s)	Vatm Perpend. (m/s)
3	1.06	166.54	13.39	1760.75	0.0569	-1.03	0.25
4	1.08	172.02	13.57	1807.17	0.0584	-1.07	0.15
5	1.17	178.44	15.10	2220.71	0.0622	-1.17	0.03
6	1.15	176.88	15.13	2231.42	0.0625	-1.15	0.06
7	1.02	171.50	16.19	2553.39	0.0623	-1.01	0.15
8	0.96	171.89	16.23	2565.68	0.0626	-0.95	0.14
9	0.86	178.14	16.94	2795.68	0.0616	-0.86	0.03
10	0.75	180.35	16.95	2800.22	0.0617	-0.75	0.00
Avg	1.01		15.44	2341.88	0.0610	-1.00	0.10
Vavg	1.00	174.28					

Run 47 Collective = 4.0 Deg Air Density = 1.27 Kg/m^3

Pt	Vatm (m/s)	Datm (Deg)	Induced Wind (m/s)	Thrust (N)	CT/s	Vatm Parallel (m/s)	Vatm Perpend. (m/s)
3	0.88	243.15	5.76	323.24	0.0105	-0.40	-0.79
4	0.88	255.65	5.73	320.16	0.0104	-0.22	-0.85
5	0.82	246.32	6.20	374.88	0.0105	-0.33	-0.75
6	0.84	244.47	6.17	371.31	0.0104	-0.36	-0.76
7	0.91	237.25	6.59	422.63	0.0103	-0.49	-0.77
8	1.05	243.34	6.55	418.53	0.0102	-0.47	-0.94
9	0.86	241.04	6.90	463.43	0.0102	-0.42	-0.75
10	0.97	236.21	6.90	463.43	0.0102	-0.54	-0.81
Avg	0.90		6.35	394.70	0.0103	-0.40	-0.80
Vavg	0.90	243.28					

Run 48 Collective = 3.0 Deg Air Density = 1.26 Kg/m^3

Pt	Vatm (m/s)	Datm (Deg)	Induced Wind (m/s)	Thrust (N)	CT/s	Vatm Parallel (m/s)	Vatm Perpend. (m/s)
3	0.40	221.92	4.44	192.13	0.0062	-0.30	-0.27
4	0.49	230.64	4.44	190.12	0.0062	-0.31	-0.38
5	0.59	226.81	4.74	217.40	0.0061	-0.40	-0.43
6	0.60	227.66	4.62	206.71	0.0058	-0.40	-0.44
7	0.73	204.68	4.83	225.71	0.0055	-0.66	-0.30
8	0.78	204.39	4.88	229.81	0.0056	-0.71	-0.32
9	1.17	207.08	5.34	275.87	0.0061	-1.04	-0.53
10	1.07	205.91	5.21	262.30	0.0058	-0.96	-0.47
Avg	0.73		4.81	225.01	0.0059	-0.60	-0.39
Vavg	0.72	213.28					

APPENDIX B

TABULATED PERFORMANCE AND BLADE LOAD DATA FOR THE ISOLATED TAIL ROTOR CONFIGURATION

A self-explanatory header is given for each run, as well as the following tabulated data.[a]

Pt	:	data point number
V_{atm}	:	ambient wind speed (m/sec)
D_{atm}	:	wind direction relative to the rotor axis (deg)
RPM	:	revolutions per minute
M_{tip}	:	tip mach number
Flap	:	measured blade flapping angle (deg)
C_T/s	:	coefficient of thrust divided by rotor solidity
C_Q/s	:	coefficient of torque divided by rotor solidity
FM	:	figure of merit
C30	:	chordwise blade bending at the 30% radial station (N·m)
F30	:	flapwise blade bending at the 30% radial station (N·m)
F40	:	flapwise blade bending at the 40% radial station (N·m)
F70	:	flapwise blade bending at the 70% radial station (N·m)
Thrust	:	rotor thrust (N)
Torque	:	rotor torque (N·m)

[a]Note that values in tables marked Vatm, Datm, Mtip, CT/s, CQ/s, and Kg/m3 should be read as V_{atm}, D_{atm}, M_{tip}, C_T/s, C_Q/s, and Kg/m^3.

Run 27 Date of Run = 3/24/87
Collective = 15.0 Deg Time of Run = 3:38:49
Air Density = 1.28 Kg/m^3 Barometric Pressure = 1.02 Bar
Temperature = 5.78 C Relative Humidity = 35.0 %

Pt	Vatm m/s	Datm deg	RPM	Mtip	Flap deg	CT/s	CQ/s	FM
4	1.45	67.55	1505	0.52	2.06	0.0758	0.01316	0.5109
5	1.24	75.39	1507	0.52	2.06	0.0756	0.01314	0.5097
6	1.81	60.26	1619	0.56	2.05	0.0750	0.01320	0.5010
7	1.45	48.89	1619	0.56	2.06	0.0746	0.01321	0.4973
8	1.88	39.98	1736	0.60	2.12	0.0744	0.01324	0.4938
9	1.98	17.52	1735	0.60	2.14	0.0742	0.01319	0.4936
10	2.18	23.97	1823	0.63	1.65	0.0746	0.01332	0.4930
11	1.88	24.32	1823	0.63	1.67	0.0746	0.01332	0.4929
12	1.97	25.23	1823	0.63	1.68	0.0746	0.01331	0.4931

Pt	C30 N-m	F30 N-m	F40 N-m	F70 N-m	Thrust N	Torque N-m
4	-65.30	-21.30	-12.14	-3.90	2324	446.0
5	-66.42	-21.00	-12.09	-4.09	2324	446.3
6	-65.63	-23.74	-13.13	-4.21	2682	521.8
7	-66.98	-23.28	-13.08	-4.51	2667	521.9
8	-61.40	-25.23	-13.75	-4.74	3059	601.7
9	-62.66	-25.08	-13.79	-4.88	3047	598.7
10	-54.06	-26.77	-14.18	-4.88	3382	667.2
11	-54.53	-27.03	-14.48	-5.25	3356	662.2
12	-54.19	-27.31	-14.57	-5.25	3356	661.7

Run 28 Date of Run = 3/24/87
Collective = 9.0 Deg Time of Run = 4:57:31
Air Density = 1.28 Kg/m^3 Barometric Pressure = 1.02 Bar
Temperature = 5.45 C Relative Humidity = 35.0 %

Pt	Vatm m/s	Datm deg	RPM	Mtip	Flap deg	CT/s	CQ/s	FM
3	1.45	0.51	1503	0.52	1.48	0.0359	0.00540	0.4061
4	1.36	0.90	1501	0.52	1.83	0.0356	0.00539	0.4007
5	1.49	40.04	1619	0.56	1.30	0.0353	0.00538	0.3977
6	1.62	41.76	1620	0.56	1.28	0.0350	0.00539	0.3924
7	1.87	41.27	1736	0.60	1.33	0.0349	0.00537	0.3906
8	2.32	40.23	1736	0.60	1.32	0.0345	0.00537	0.3847
9	2.55	39.42	1820	0.63	1.30	0.0340	0.00535	0.3766
10	2.37	36.28	1820	0.63	1.26	0.0342	0.00535	0.3818

Pt	C30 N-m	F30 N-m	F40 N-m	F70 N-m	Thrust N	Torque N-m
3	-91.35	-36.82	-21.66	-3.65	1106	183.9
4	-95.77	-33.33	-19.79	-5.37	1094	183.1
5	-95.73	-42.37	-23.99	-2.80	1262	212.7
6	-95.44	-42.59	-24.07	-2.83	1253	213.1
7	-97.89	-46.86	-25.68	-2.70	1435	244.1
8	-99.18	-46.66	-25.69	-2.92	1418	244.2
9	-95.61	-50.19	-27.10	-3.13	1536	267.2
10	-94.14	-50.48	-27.09	-2.91	1545	266.9

Run 29 Date of Run = 3/24/87
Collective = 4.0 Deg Time of Run = 5:31: 8
Air Density = 1.28 Kg/m^3 Barometric Pressure = 1.02 Bar
Temperature = 5.25 C Relative Humidity = 35.0 %

Pt	Vatm m/s	Datm deg	RPM	Mtip	Flap deg	CT/s	CQ/s	FM
3	2.53	358.73	1503	0.52	0.37	0.0085	0.00245	0.1031
4	2.47	359.86	1503	0.52	0.38	0.0085	0.00245	0.1026
5	2.67	347.97	1620	0.56	0.41	0.0087	0.00243	0.1083
6	2.52	336.17	1620	0.56	0.39	0.0090	0.00246	0.1122
7	2.63	336.11	1735	0.60	0.47	0.0094	0.00247	0.1192
8	2.61	331.67	1735	0.60	0.45	0.0096	0.00245	0.1230
9	2.33	321.14	1822	0.63	0.47	0.0095	0.00244	0.1229
10	2.66	320.52	1823	0.63	0.43	0.0096	0.00246	0.1225

Pt	C30 N-m	F30 N-m	F40 N-m	F70 N-m	Thrust N	Torque N-m
3	-103.48	-46.84	-27.82	-2.67	261	83.3
4	-104.64	-46.62	-27.77	-2.76	261	83.4
5	-112.24	-52.13	-29.89	-2.43	311	96.2
6	-111.15	-52.14	-29.85	-2.34	322	97.3
7	-113.77	-57.00	-31.72	-2.07	386	112.0
8	-112.41	-57.08	-31.68	-1.96	394	111.1
9	-113.70	-60.56	-32.91	-1.82	430	122.2
10	-112.94	-60.93	-33.05	-1.81	435	123.2

Run 30 Date of Run = 3/24/87
Collective = 0.0 Deg Time of Run = 9:16:28
Air Density = 1.24 Kg/m^3 Barometric Pressure = 1.02 Bar
Temperature = 14.79 C Relative Humidity = 35.0 %

Pt	Vatm m/s	Datm deg	RPM	Mtip	Flap deg	CT/s	CQ/s	FM
3	1.81	77.30	1601	0.55	0.51	0.0005	0.00257	0.0013
4	2.46	26.30	1821	0.62	0.63	0.0010	0.00194	0.0055
5	6.23	15.19	1821	0.62	0.68	-0.0012	0.00200	0.0071
6	5.69	19.85	1824	0.62	0.67	-0.0011	0.00199	0.0058
7	5.92	10.65	1824	0.62	0.71	-0.0012	0.00201	0.0069

Pt	C30 N-m	F30 N-m	F40 N-m	F70 N-m	Thrust N	Torque N-m
3	-106.58	-66.91	-37.21	-2.07	16	96.1
4	-106.45	-65.88	-36.88	-2.11	43	94.1
5	-108.90	-67.93	-37.78	-1.79	-52	96.9
6	-109.84	-68.57	-38.05	-1.68	-47	95.7
7	-110.47	-68.51	-38.11	-1.96	-52	97.0

Run 31 Date of Run = 3/25/87
Collective = -13.0 Deg Time of Run = 2:42:19
Air Density = 1.27 Kg/m^3 Barometric Pressure = 1.02 Bar
Temperature = 6.28 C Relative Humidity = 38.0 %

Pt	Vatm m/s	Datm deg	RPM	Mtip	Flap deg	CT/s	CQ/s	FM
6	1.50	263.66	1506	0.52	-0.68	-0.0508	0.01149	0.3211
7	1.59	256.20	1506	0.52	-0.57	-0.0505	0.01140	0.3207
8	1.58	247.13	1622	0.56	-0.66	-0.0503	0.01160	0.3136
9	1.62	257.47	1622	0.56	-0.69	-0.0505	0.01159	0.3151
10	1.35	249.24	1737	0.60	-0.71	-0.0508	0.01188	0.3101
11	1.19	236.02	1736	0.60	-0.66	-0.0509	0.01189	0.3109

Pt	C30 N-m	F30 N-m	F40 N-m	F70 N-m	Thrust N	Torque N-m
6	-95.04	-69.55	-42.87	-1.77	-1559	389.7
7	-97.48	-67.87	-41.97	-2.38	-1550	386.6
8	-102.86	-77.36	-46.16	-1.18	-1791	456.4
9	-102.23	-77.77	-46.30	-1.03	-1798	456.1
10	-100.45	-85.44	-49.37	-0.49	-2074	536.0
11	-101.36	-85.17	-49.27	-0.49	-2076	535.9

Run 32 Date of Run = 3/25/87
Collective = -9.0 Deg Time of Run = 3:45: 5
Air Density = 1.27 Kg/m^3 Barometric Pressure = 1.02 Bar
Temperature = 6.88 C Relative Humidity = 38.0 %

Pt	Vatm m/s	Datm deg	RPM	Mtip	Flap deg	CT/s	CQ/s	FM
3	0.60	248.65	1509	0.52	0.02	-0.0293	0.00580	0.2783
4	0.53	255.23	1508	0.52	0.01	-0.0294	0.00581	0.2790
5	0.43	246.09	1623	0.56	0.04	-0.0294	0.00582	0.2791
6	0.50	233.29	1623	0.56	0.04	-0.0293	0.00580	0.2792
7	0.37	205.36	1739	0.60	0.00	-0.0296	0.00589	0.2789
8	0.52	190.65	1739	0.60	0.02	-0.0294	0.00585	0.2778
9	0.77	176.30	1798	0.62	0.08	-0.0294	0.00591	0.2754
10	0.69	179.18	1798	0.62	0.06	-0.0293	0.00590	0.2745

Pt	C30 N-m	F30 N-m	F40 N-m	F70 N-m	Thrust N	Torque N-m
3	-108.19	-61.94	-38.71	-3.24	-903	197.7
4	-107.94	-61.89	-38.62	-3.20	-905	197.8
5	-116.99	-68.39	-41.30	-2.73	-1048	229.5
6	-117.04	-68.56	-41.42	-2.75	-1044	228.5
7	-118.04	-75.69	-44.22	-2.34	-1211	266.2
8	-117.09	-75.21	-44.01	-2.37	-1203	264.6
9	-114.02	-78.44	-45.31	-2.21	-1286	285.6
10	-114.24	-78.55	-45.32	-2.23	-1282	285.2

Run 33 Date of Run = 3/25/87
Collective = -5.0 Deg Time of Run = 4: 9:55
Air Density = 1.27 Kg/m^3 Barometric Pressure = 1.02 Bar
Temperature = 6.35 C Relative Humidity = 38.0 %

Pt	Vatm m/s	Datm deg	RPM	Mtip	Flap deg	CT/s	CQ/s	FM
3	0.16	228.86	1507	0.52	0.76	-0.0107	0.00313	0.1139
4	0.19	195.19	1507	0.52	0.75	-0.0108	0.00317	0.1143
5	-0.01	242.82	1621	0.56	0.70	-0.0109	0.00315	0.1165
6	0.06	291.49	1620	0.56	0.70	-0.0109	0.00315	0.1160
7	-0.01	278.43	1739	0.60	0.76	-0.0109	0.00311	0.1180
8	-0.01	278.37	1739	0.60	0.71	-0.0108	0.00311	0.1169
9	-0.01	291.98	1825	0.63	0.76	-0.0110	0.00311	0.1192
10	-0.01	323.96	1825	0.63	0.74	-0.0112	0.00314	0.1210

Pt	C30 N-m	F30 N-m	F40 N-m	F70 N-m	Thrust N	Torque N-m
3	-109.28	-54.23	-33.64	-2.98	-328	106.2
4	-110.89	-54.13	-33.56	-3.10	-332	107.7
5	-118.21	-61.04	-36.42	-2.81	-387	123.9
6	-118.44	-60.96	-36.39	-2.86	-387	123.5
7	-122.38	-66.74	-38.70	-2.68	-446	140.9
8	-122.42	-66.68	-38.66	-2.58	-442	140.8
9	-122.74	-71.27	-40.34	-2.29	-495	155.2
10	-121.49	-71.20	-40.31	-2.41	-504	156.5

Run 34 Date of Run = 3/25/87
Collective = -1.0 Deg Time of Run = 4:36:25
Air Density = 1.27 Kg/m^3 Barometric Pressure = 1.02 Bar
Temperature = 6.00 C Relative Humidity = 38.0 %

Pt	Vatm m/s	Datm deg	RPM	Mtip	Flap deg	CT/s	CQ/s	FM
3	1.28	328.53	1503	0.52	0.96	-0.0007	0.00208	0.0028
4	1.29	323.83	1503	0.52	0.96	-0.0008	0.00208	0.0036
5	1.65	313.78	1620	0.56	0.95	-0.0007	0.00205	0.0031
6	1.78	310.22	1620	0.56	0.96	-0.0007	0.00202	0.0031
7	1.71	318.90	1737	0.60	1.03	-0.0008	0.00204	0.0034
8	1.72	315.08	1737	0.60	1.00	-0.0007	0.00204	0.0028
9	1.70	289.87	1825	0.63	0.99	-0.0002	0.00203	0.0003
10	1.59	297.78	1825	0.63	0.97	-0.0003	0.00202	0.0007

Pt	C30 N-m	F30 N-m	F40 N-m	F70 N-m	Thrust N	Torque N-m
3	-103.57	-50.13	-30.42	-2.84	-21	70.4
4	-103.55	-50.23	-30.50	-2.91	-24	70.4
5	-113.45	-56.19	-32.85	-2.62	-24	80.4
6	-114.55	-56.17	-32.91	-2.72	-24	79.5
7	-118.69	-61.28	-34.81	-2.47	-32	92.1
8	-117.37	-61.76	-34.95	-2.43	-28	91.9
9	-115.83	-66.59	-36.88	-2.19	-9	101.1
10	-114.38	-66.53	-36.76	-2.02	-13	100.8

Run 35 Date of Run = 3/25/87
Collective = 0.0 Deg Time of Run = 5: 4:47
Air Density = 1.27 Kg/m^3 Barometric Pressure = 1.02 Bar
Temperature = 6.10 C Relative Humidity = 38.0 %

Pt	Vatm m/s	Datm deg	RPM	Mtip	Flap deg	CT/s	CQ/s	FM
4	1.77	294.37	1506	0.52	0.76	0.0010	0.00184	0.0058
5	1.76	294.34	1505	0.52	0.72	0.0009	0.00184	0.0049
6	1.79	293.56	1620	0.56	0.78	0.0009	0.00184	0.0049
7	1.78	294.05	1620	0.56	0.78	0.0009	0.00183	0.0045
8	1.71	299.07	1731	0.60	0.82	0.0007	0.00182	0.0030
9	1.76	303.64	1736	0.60	0.82	0.0006	0.00184	0.0023
10	2.09	309.60	1825	0.63	0.75	0.0004	0.00184	0.0014
11	1.95	307.34	1825	0.63	0.72	0.0005	0.00184	0.0021

Pt	C30 N-m	F30 N-m	F40 N-m	F70 N-m	Thrust N	Torque N-m
4	-106.70	-49.93	-30.37	-3.09	30	62.5
5	-107.10	-49.92	-30.33	-3.13	27	62.3
6	-112.97	-55.82	-32.72	-2.87	31	72.1
7	-113.44	-55.78	-32.73	-2.92	31	72.0
8	-113.99	-60.59	-34.43	-2.72	28	81.5
9	-114.87	-60.67	-34.50	-2.79	24	82.9
10	-112.02	-65.49	-36.26	-2.41	18	91.6
11	-110.64	-65.51	-36.24	-2.38	22	91.5

Run 36 Date of Run = 3/25/87
Collective = -3.0 Deg Time of Run = 5:33: 0
Air Density = 1.27 Kg/m^3 Barometric Pressure = 1.02 Bar
Temperature = 6.20 C Relative Humidity = 38.0 %

Pt	Vatm m/s	Datm deg	RPM	Mtip	Flap deg	CT/s	CQ/s	FM
3	1.14	261.94	1505	0.52	0.72	-0.0039	0.00239	0.0329
4	0.78	266.28	1505	0.52	0.46	-0.0036	0.00235	0.0301
5	0.43	241.07	1621	0.56	0.46	-0.0038	0.00234	0.0329
6	1.39	131.94	1621	0.56	0.48	-0.0038	0.00233	0.0323
7	1.63	127.60	1737	0.60	0.45	-0.0035	0.00229	0.0285
8	1.47	140.14	1737	0.60	0.44	-0.0035	0.00229	0.0286
9	1.12	173.25	1822	0.63	0.41	-0.0035	0.00234	0.0288
10	0.69	228.21	1822	0.63	0.36	-0.0032	0.00230	0.0253

Pt	C30 N-m	F30 N-m	F40 N-m	F70 N-m	Thrust N	Torque N-m
3	-112.80	-49.00	-30.04	-3.94	-119	81.0
4	-110.80	-51.06	-31.18	-2.87	-110	79.7
5	-116.48	-58.39	-34.16	-2.38	-135	91.9
6	-115.70	-58.29	-34.12	-2.25	-135	91.6
7	-118.85	-63.86	-36.19	-2.26	-142	103.5
8	-119.06	-63.62	-36.06	-2.25	-142	103.4
9	-118.50	-67.97	-37.67	-2.07	-157	116.2
10	-119.20	-68.28	-37.73	-1.98	-143	114.0

Run 37 Date of Run = 3/25/87
Collective = 5.0 Deg Time of Run = 6: 0:28
Air Density = 1.27 Kg/m^3 Barometric Pressure = 1.02 Bar
Temperature = 6.53 C Relative Humidity = 5.1 %

Pt	Vatm m/s	Datm deg	RPM	Mtip	Flap deg	CT/s	CQ/s	FM
3	0.88	191.11	1523	0.53	0.68	0.0142	0.00276	0.1983
4	0.84	179.15	1509	0.52	0.68	0.0137	0.00274	0.1882
5	1.16	169.14	1623	0.56	0.65	0.0136	0.00276	0.1859
6	1.37	174.77	1623	0.56	0.64	0.0130	0.00270	0.1768
7	1.05	182.91	1700	0.59	0.70	0.0135	0.00284	0.1771
8	1.08	187.15	1729	0.60	0.70	0.0134	0.00276	0.1811
9	1.10	191.79	1826	0.63	0.54	0.0140	0.00282	0.1888
10	1.12	194.96	1820	0.63	0.50	0.0141	0.00284	0.1909

Pt	C30 N-m	F30 N-m	F40 N-m	F70 N-m	Thrust N	Torque N-m
3	-96.30	-46.52	-27.92	-2.04	445	95.7
4	-96.52	-46.50	-28.13	-2.20	422	93.3
5	-97.45	-51.90	-30.09	-1.67	484	108.6
6	-97.15	-52.31	-30.29	-1.58	463	106.3
7	-105.04	-57.10	-32.05	-1.54	528	122.7
8	-104.52	-57.02	-31.98	-1.48	542	123.5
9	-100.52	-62.13	-33.80	-1.31	631	140.5
10	-99.08	-62.35	-33.86	-1.12	632	140.5

Run 38 Date of Run = 3/25/87
Collective = 13.0 Deg Time of Run = 9: 9: 9
Air Density = 1.22 Kg/m^3 Barometric Pressure = 1.02 Bar
Temperature = 18.74 C Relative Humidity = 53.0 %

Pt	Vatm m/s	Datm deg	RPM	Mtip	Flap deg	CT/s	CQ/s	FM
3	1.89	108.86	1538	0.52	1.70	0.0655	0.01051	0.5137
4	1.65	98.40	1541	0.52	1.69	0.0650	0.01046	0.5107
5	1.73	94.87	1656	0.56	1.73	0.0645	0.01047	0.5038
6	1.39	100.21	1656	0.56	1.72	0.0655	0.01058	0.5107
7	2.11	88.81	1776	0.60	1.67	0.0632	0.01046	0.4890
8	1.67	91.53	1776	0.60	1.69	0.0639	0.01051	0.4952
9	1.95	111.04	1850	0.63	1.23	0.0645	0.01059	0.4982
10	1.89	106.73	1851	0.63	1.20	0.0640	0.01051	0.4961

Pt	C30 N-m	F30 N-m	F40 N-m	F70 N-m	Thrust N	Torque N-m
3	-61.88	-28.99	-17.56	-3.63	2014	357.0
4	-60.69	-29.16	-17.61	-3.66	2007	356.8
5	-64.38	-31.94	-18.75	-3.97	2300	412.6
6	-63.54	-31.69	-18.52	-3.93	2335	416.8
7	-55.66	-36.21	-20.30	-3.87	2592	474.3
8	-55.28	-35.90	-20.14	-3.91	2621	476.5
9	-49.82	-38.08	-20.80	-3.93	2870	520.7
10	-48.94	-38.43	-20.87	-3.78	2851	517.2

Run 39 Date of Run = 3/26/87
Collective = 15.0 Deg Time of Run = 2:57:14
Air Density = 1.27 Kg/m^3 Barometric Pressure = 1.02 Bar
Temperature = 6.73 C Relative Humidity = 55.0 %

Pt	Vatm m/s	Datm deg	RPM	Mtip	Flap deg	CT/s	CQ/s	FM
3	0.42	333.81	1505	0.52	1.51	0.0772	0.01314	0.5257
4	0.62	325.06	1505	0.52	0.69	0.0771	0.01315	0.5244
5	0.82	323.67	1623	0.56	1.56	0.0772	0.01326	0.5208
6	0.86	320.26	1621	0.56	1.55	0.0772	0.01325	0.5218
7	0.92	325.51	1739	0.60	1.53	0.0787	0.01359	0.5232
8	0.90	316.02	1739	0.60	1.54	0.0787	0.01361	0.5231
9	0.98	314.20	1825	0.63	1.18	0.0789	0.01370	0.5210
10	0.93	319.23	1826	0.63	1.20	0.0788	0.01369	0.5201

Pt	C30 N-m	F30 N-m	F40 N-m	F70 N-m	Thrust N	Torque N-m
3	-55.53	-21.07	-12.48	-3.98	2367	445.1
4	-56.26	-21.03	-12.51	-4.14	2364	445.4
5	-56.82	-23.30	-13.39	-4.30	2752	522.4
6	-56.94	-23.21	-13.37	-4.37	2746	520.9
7	-44.49	-24.34	-13.48	-4.40	3221	614.9
8	-44.24	-24.25	-13.45	-4.53	3221	615.5
9	-38.24	-26.49	-14.09	-4.37	3557	682.7
10	-38.66	-26.32	-14.06	-4.45	3556	682.8

Run 40 Date of Run = 3/26/87
Collective = 7.0 Deg Time of Run = 3:22:29
Air Density = 1.27 Kg/m^3 Barometric Pressure = 1.02 Bar
Temperature = 7.11 C Relative Humidity = 55.0 %

Pt	Vatm m/s	Datm deg	RPM	Mtip	Flap deg	CT/s	CQ/s	FM
3	1.83	317.32	1508	0.52	0.69	0.0244	0.00380	0.3231
4	1.82	314.92	1508	0.52	0.70	0.0244	0.00379	0.3237
5	1.48	310.06	1624	0.56	0.73	0.0247	0.00382	0.3263
6	1.48	310.38	1624	0.56	0.71	0.0246	0.00384	0.3239
7	1.45	304.10	1740	0.60	0.69	0.0247	0.00383	0.3272
8	1.52	302.57	1740	0.60	0.67	0.0247	0.00382	0.3280
9	1.69	300.82	1827	0.63	0.68	0.0247	0.00383	0.3271
10	1.70	304.16	1827	0.63	0.67	0.0247	0.00385	0.3242

Pt	C30 N-m	F30 N-m	F40 N-m	F70 N-m	Thrust N	Torque N-m
3	-90.53	-42.91	-25.45	-1.91	751	129.2
4	-90.29	-42.85	-25.40	-1.91	751	129.0
5	-99.25	-47.63	-27.31	-1.78	881	150.8
6	-99.02	-47.69	-27.33	-1.80	878	151.3
7	-98.96	-52.23	-29.03	-1.65	1012	173.5
8	-98.91	-52.16	-28.98	-1.65	1012	173.1
9	-94.37	-56.35	-30.43	-1.44	1116	191.3
10	-93.93	-56.11	-30.41	-1.52	1116	192.1

Run 41 Date of Run = 3/26/87
Collective = 13.0 Deg Time of Run = 3:53: 4
Air Density = 1.27 Kg/m^3 Barometric Pressure = 1.02 Bar
Temperature = 7.14 C Relative Humidity = 55.0 %

Pt	Vatm m/s	Datm deg	RPM	Mtip	Flap deg	CT/s	CQ/s	FM
3	1.67	265.18	1507	0.52	0.90	0.0660	0.01071	0.5105
4	1.82	259.31	1507	0.52	0.88	0.0643	0.01039	0.5053
5	1.69	264.14	1625	0.56	0.97	0.0640	0.01033	0.5046
6	1.67	267.80	1625	0.56	0.92	0.0635	0.01020	0.5061
7	1.54	264.50	1741	0.60	0.86	0.0646	0.01071	0.4942
8	1.52	269.94	1741	0.60	0.86	0.0640	0.01038	0.5026
9	1.64	257.11	1827	0.63	0.80	0.0652	0.01064	0.5043
10	1.55	259.57	1826	0.63	0.74	0.0641	0.01073	0.4865

Pt	C30 N-m	F30 N-m	F40 N-m	F70 N-m	Thrust N	Torque N-m
3	-65.14	-26.42	-15.71	-3.86	2029	363.7
4	-65.68	-26.90	-15.67	-3.16	1976	353.0
5	-70.48	-29.52	-16.94	-3.53	2287	408.0
6	-69.55	-30.43	-17.15	-3.12	2269	402.7
7	-60.40	-33.39	-18.16	-3.69	2650	485.5
8	-62.70	-33.49	-18.28	-3.47	2626	470.6
9	-59.34	-34.31	-18.29	-3.43	2946	531.2
10	-58.63	-35.05	-18.70	-3.90	2893	535.4

Run 42 Date of Run = 3/26/87
Collective = 1.0 Deg Time of Run = 4:14:40
Air Density = 1.27 Kg/m^3 Barometric Pressure = 1.02 Bar
Temperature = 6.94 C Relative Humidity = 55.0 %

Pt	Vatm m/s	Datm deg	RPM	Mtip	Flap deg	CT/s	CQ/s	FM
3	1.78	274.09	1508	0.52	0.54	0.0025	0.00205	0.0199
4	1.76	275.22	1508	0.52	0.52	0.0025	0.00205	0.0200
5	1.17	278.69	1622	0.56	0.47	0.0024	0.00202	0.0184
6	1.17	277.91	1622	0.56	0.47	0.0024	0.00201	0.0186
7	1.34	270.88	1743	0.60	0.51	0.0023	0.00203	0.0177
8	1.20	272.63	1743	0.60	0.50	0.0023	0.00203	0.0175
9	0.98	274.54	1828	0.63	0.43	0.0023	0.00202	0.0181
10	1.08	270.69	1828	0.63	0.46	0.0024	0.00202	0.0182

Pt	C30 N-m	F30 N-m	F40 N-m	F70 N-m	Thrust N	Torque N-m
3	-103.49	-50.69	-31.13	-3.10	76	69.9
4	-103.53	-50.66	-31.10	-3.14	76	69.6
5	-113.67	-56.21	-33.35	-2.88	85	79.6
6	-113.36	-56.28	-33.35	-2.80	85	79.1
7	-114.83	-62.24	-35.68	-2.59	94	92.2
8	-114.61	-62.26	-35.68	-2.59	94	92.2
9	-113.14	-66.74	-37.27	-2.35	104	101.0
10	-114.44	-66.44	-37.19	-2.46	108	100.9

Run 43 Date of Run = 3/26/87
Collective = 9.0 Deg Time of Run = 4:38:25
Air Density = 1.27 Kg/m^3 Barometric Pressure = 1.02 Bar
Temperature = 6.76 C Relative Humidity = 55.0 %

Pt	Vatm m/s	Datm deg	RPM	Mtip	Flap deg	CT/s	CQ/s	FM
3	1.03	254.23	1510	0.52	0.91	0.0368	0.00552	0.4121
4	1.05	256.30	1510	0.52	0.89	0.0365	0.00552	0.4061
5	1.09	259.05	1622	0.56	0.88	0.0353	0.00545	0.3912
6	1.14	257.31	1621	0.56	0.87	0.0364	0.00539	0.4148
7	1.44	268.00	1739	0.60	0.86	0.0365	0.00542	0.4142
8	1.39	270.20	1739	0.60	0.87	0.0367	0.00549	0.4122
9	1.48	265.15	1827	0.63	0.70	0.0362	0.00551	0.4030
10	1.51	268.81	1827	0.63	0.69	0.0364	0.00549	0.4077

Pt	C30 N-m	F30 N-m	F40 N-m	F70 N-m	Thrust N	Torque N-m
3	-83.12	-38.38	-22.80	-2.29	1135	188.4
4	-83.53	-38.46	-22.89	-2.54	1126	188.3
5	-91.26	-42.82	-24.70	-2.54	1257	214.5
6	-92.63	-42.51	-24.53	-2.37	1294	211.7
7	-91.27	-47.39	-26.27	-2.19	1494	245.0
8	-90.89	-46.98	-26.08	-2.36	1502	248.1
9	-87.77	-49.98	-27.25	-2.45	1635	275.0
10	-86.82	-50.31	-27.33	-2.34	1644	274.2

Run 44 Date of Run = 3/26/87
Collective = 11.0 Deg Time of Run = 5:11:50
Air Density = 1.27 Kg/m^3 Barometric Pressure = 1.02 Bar
Temperature = 6.75 C Relative Humidity = 55.0 %

Pt	Vatm m/s	Datm deg	RPM	Mtip	Flap deg	CT/s	CQ/s	FM
3	0.24	270.46	1508	0.52	1.00	0.0500	0.00763	0.4724
4	0.31	266.02	1508	0.52	1.01	0.0501	0.00765	0.4724
5	0.00	270.72	1624	0.56	1.00	0.0483	0.00752	0.4543
6	-0.01	270.62	1624	0.56	0.99	0.0489	0.00755	0.4610
7	0.06	26.85	1741	0.60	0.99	0.0495	0.00767	0.4634
8	0.18	105.11	1741	0.60	0.99	0.0491	0.00761	0.4605
9	0.21	120.98	1826	0.63	0.70	0.0493	0.00764	0.4613
10	0.18	134.40	1826	0.63	0.71	0.0493	0.00765	0.4610

Pt	C30 N-m	F30 N-m	F40 N-m	F70 N-m	Thrust N	Torque N-m
3	-77.72	-33.73	-20.03	-2.89	1539	259.5
4	-78.26	-33.46	-19.91	-2.96	1542	260.1
5	-82.73	-37.87	-21.73	-2.93	1724	296.6
6	-82.81	-37.75	-21.65	-2.93	1745	297.7
7	-78.47	-41.49	-22.96	-2.91	2031	347.5
8	-79.54	-41.41	-22.94	-2.95	2014	344.9
9	-71.96	-44.75	-23.98	-2.76	2225	381.3
10	-75.12	-43.90	-23.78	-3.05	2225	381.8

Run 45 Date of Run = 3/26/87
Collective = 5.0 Deg Time of Run = 5:34:16
Air Density = 1.27 Kg/m^3 Barometric Pressure = 1.02 Bar
Temperature = 6.41 C Relative Humidity = 55.0 %

Pt	Vatm m/s	Datm deg	RPM	Mtip	Flap deg	CT/s	CQ/s	FM
3	0.91	166.09	1505	0.52	0.67	0.0134	0.00254	0.1972
4	0.89	166.06	1505	0.52	0.67	0.0129	0.00250	0.1883
5	1.31	166.67	1623	0.56	0.64	0.0128	0.00252	0.1851
6	1.59	166.09	1623	0.56	0.67	0.0140	0.00258	0.2066
7	1.55	159.38	1738	0.60	0.73	0.0132	0.00258	0.1892
8	1.51	154.98	1738	0.60	0.75	0.0141	0.00261	0.2068
9	1.40	153.32	1824	0.63	0.63	0.0136	0.00260	0.1962
10	1.38	154.75	1827	0.63	0.65	0.0136	0.00263	0.1938

Pt	C30 N-m	F30 N-m	F40 N-m	F70 N-m	Thrust N	Torque N-m
3	-96.34	-46.82	-28.17	-1.78	410	85.9
4	-96.82	-46.75	-28.16	-1.91	395	84.8
5	-106.56	-52.23	-30.38	-1.68	456	99.3
6	-106.21	-51.67	-30.10	-1.60	499	101.7
7	-106.68	-57.41	-32.39	-1.37	539	116.7
8	-107.25	-56.70	-32.02	-1.40	581	118.9
9	-101.96	-62.36	-34.08	-1.02	617	130.5
10	-104.12	-61.74	-33.93	-1.20	619	132.2

Run 46 Date of Run = 3/26/87
Collective = 13.0 Deg Time of Run = 5:56:41
Air Density = 1.27 Kg/m^3 Barometric Pressure = 1.02 Bar
Temperature = 7.18 C Relative Humidity = 55.0 %

Pt	Vatm m/s	Datm deg	RPM	Mtip	Flap deg	CT/s	CQ/s	FM
3	1.06	166.54	1506	0.52	0.89	0.0569	0.00958	0.4566
4	1.08	172.02	1506	0.52	0.91	0.0584	0.00969	0.4689
5	1.17	178.44	1624	0.56	0.98	0.0622	0.01010	0.4956
6	1.15	176.88	1624	0.56	0.98	0.0625	0.01014	0.4958
7	1.02	171.50	1740	0.60	0.99	0.0623	0.01015	0.4936
8	0.96	171.89	1740	0.60	1.00	0.0626	0.01020	0.4947
9	0.86	178.14	1831	0.63	0.75	0.0616	0.01018	0.4837
10	0.75	180.35	1831	0.63	0.71	0.0617	0.01021	0.4837

Pt	C30 N-m	F30 N-m	F40 N-m	F70 N-m	Thrust N	Torque N-m
3	-71.57	-28.95	-17.02	-3.09	1760	327.7
4	-72.38	-27.97	-16.28	-2.79	1807	331.4
5	-73.36	-30.17	-17.02	-3.05	2220	398.2
6	-73.30	-30.19	-17.07	-3.18	2231	400.0
7	-69.13	-33.47	-18.24	-3.09	2553	459.8
8	-68.58	-33.34	-18.19	-3.15	2565	462.1
9	-60.87	-36.93	-19.63	-3.33	2795	510.3
10	-59.84	-37.14	-19.75	-3.47	2800	512.0

Run 47 Date of Run = 3/26/87
Collective = 4.0 Deg Time of Run = 6:21:37
Air Density = 1.27 Kg/m^3 Barometric Pressure = 1.02 Bar
Temperature = 7.60 C Relative Humidity = 55.0 %

Pt	Vatm m/s	Datm deg	RPM	Mtip	Flap deg	CT/s	CQ/s	FM
3	0.88	243.15	1508	0.52	0.78	0.0105	0.00246	0.1405
4	0.88	255.65	1508	0.52	0.76	0.0104	0.00249	0.1381
5	0.82	246.32	1624	0.56	0.74	0.0105	0.00250	0.1379
6	0.84	244.47	1624	0.56	0.73	0.0104	0.00245	0.1382
7	0.91	237.25	1741	0.60	0.76	0.0103	0.00247	0.1354
8	1.05	243.34	1741	0.60	0.74	0.0102	0.00247	0.1341
9	0.86	241.04	1832	0.63	0.68	0.0102	0.00247	0.1344
10	0.97	236.21	1832	0.63	0.67	0.0102	0.00248	0.1337

Pt	C30 N-m	F30 N-m	F40 N-m	F70 N-m	Thrust N	Torque N-m
3	-100.33	-47.68	-28.86	-1.96	323	83.8
4	-100.23	-47.55	-28.81	-1.98	320	84.6
5	-106.32	-53.27	-31.10	-1.75	374	98.6
6	-106.91	-53.20	-31.06	-1.77	371	96.8
7	-108.70	-58.44	-33.12	-1.62	422	112.0
8	-109.41	-58.52	-33.14	-1.67	418	112.0
9	-103.17	-63.32	-34.76	-1.26	463	124.2
10	-102.76	-63.55	-34.84	-1.22	463	124.4

Run 48 Date of Run = 3/26/87
Collective = 3.0 Deg Time of Run = 6:42:56
Air Density = 1.26 Kg/m^3 Barometric Pressure = 1.02 Bar
Temperature = 9.35 C Relative Humidity = 55.0 %

Pt	Vatm m/s	Datm deg	RPM	Mtip	Flap deg	CT/s	CQ/s	FM
3	0.40	221.92	1513	0.52	0.79	0.0062	0.00217	0.0726
4	0.49	230.64	1511	0.52	0.73	0.0062	0.00218	0.0728
5	0.59	226.81	1629	0.56	0.65	0.0061	0.00219	0.0698
6	0.60	227.66	1629	0.56	0.62	0.0058	0.00214	0.0664
7	0.73	204.68	1748	0.60	0.67	0.0055	0.00217	0.0599
8	0.78	204.39	1748	0.60	0.66	0.0056	0.00218	0.0619
9	1.17	207.08	1835	0.63	0.61	0.0061	0.00223	0.0683
10	1.07	205.91	1835	0.63	0.62	0.0058	0.00221	0.0650

Pt	C30 N-m	F30 N-m	F40 N-m	F70 N-m	Thrust N	Torque N-m
3	-105.22	-47.72	-29.30	-2.52	192	74.3
4	-103.13	-48.59	-29.63	-2.17	190	73.8
5	-110.29	-54.50	-31.99	-1.82	217	86.2
6	-110.69	-54.93	-32.18	-1.82	206	84.4
7	-110.75	-61.08	-34.48	-1.52	225	98.4
8	-111.25	-60.86	-34.41	-1.56	229	98.7
9	-109.45	-65.02	-35.86	-1.44	275	111.4
10	-109.63	-65.24	-35.98	-1.46	262	110.5

REFERENCES

1. Owen, T. B.; and Beauchamp, A. R.: Aero-Acoustic Measurements on a Lynx Tail Rotor in the RAE 24-Foot Wind Tunnel. RAE-TM-Aero-1972, July 1983.

2. Gregory, N.; and Wilby, P. G.: NPL 9615 and NACA 0012, A Comparison of Aerodynamic Data. NASA CP 1261, 1973.

TABLE I.– ROTOR BALANCE ACCURACY

	Combined loading condition	
	Positive thrust and torque, %	Negative thrust and torque, %
Calculated thrust accuracy (% maximum thrust)	±1	±2
Calculated torque accuracy (% maximum torque)	±2	±4

TABLE II.– ISOLATED TAIL ROTOR CONFIGURATION TEST CONDITIONS

The wind direction is relative to the rotor axis. The rotor axis is defined by the 0°-180° line, where 0° is upstream of the rotor. Angles increase in the clockwise direction looking down on the rotor (see figs. 5-10). The windspeed and direction have been vector-averaged. Only the data points where $M_{tip} > 0.5$ are included in the average.

Run	Collective, deg	M_{tip}	Windspeed, m/sec	Wind direction, deg
27	15	0.52, 0.56, 0.60, 0.63	1.66	39.5
28	9	0.52, 0.56, 0.60, 0.63	1.81	32.6
29	4	0.52, 0.56, 0.60, 0.63	2.48	339.0
30	0	0.52, 0.62	4.23	20.8
31	–13	0.52, 0.56, 0.60	1.46	252.3
32	–9	0.52, 0.56, 0.60, 0.62	0.47	213.4
33	–5	0.52, 0.56, 0.60, 0.63	0.04	213.4
34	–1	0.52, 0.56, 0.60, 0.63	1.56	311.5
35	0	0.52, 0.56, 0.60, 0.63	1.81	299.8
36	–3	0.52, 0.56, 0.60, 0.63	0.63	173.2
37	5	0.52, 0.56, 0.60, 0.63	1.06	183.5
38	13	0.52, 0.56, 0.60, 0.63	1.77	100.1
39	15	0.52, 0.56, 0.60, 0.63	0.80	321.1
40	7	0.52, 0.56, 0.60, 0.63	1.61	308.3
41	13	0.52, 0.56, 0.60, 0.63	1.63	263.4
42	1	0.52, 0.56, 0.60, 0.63	1.31	274.3
43	9	0.52, 0.56, 0.60, 0.63	1.26	263.2
44	11	0.52, 0.56, 0.60, 0.63	0.03	186.8
45	5	0.52, 0.56, 0.60, 0.63	1.31	160.4
46	13	0.52, 0.56, 0.60, 0.63	1.00	174.3
47	4	0.52, 0.56, 0.60, 0.63	0.90	243.3
48	3	0.52, 0.56, 0.60, 0.63	0.72	213.3

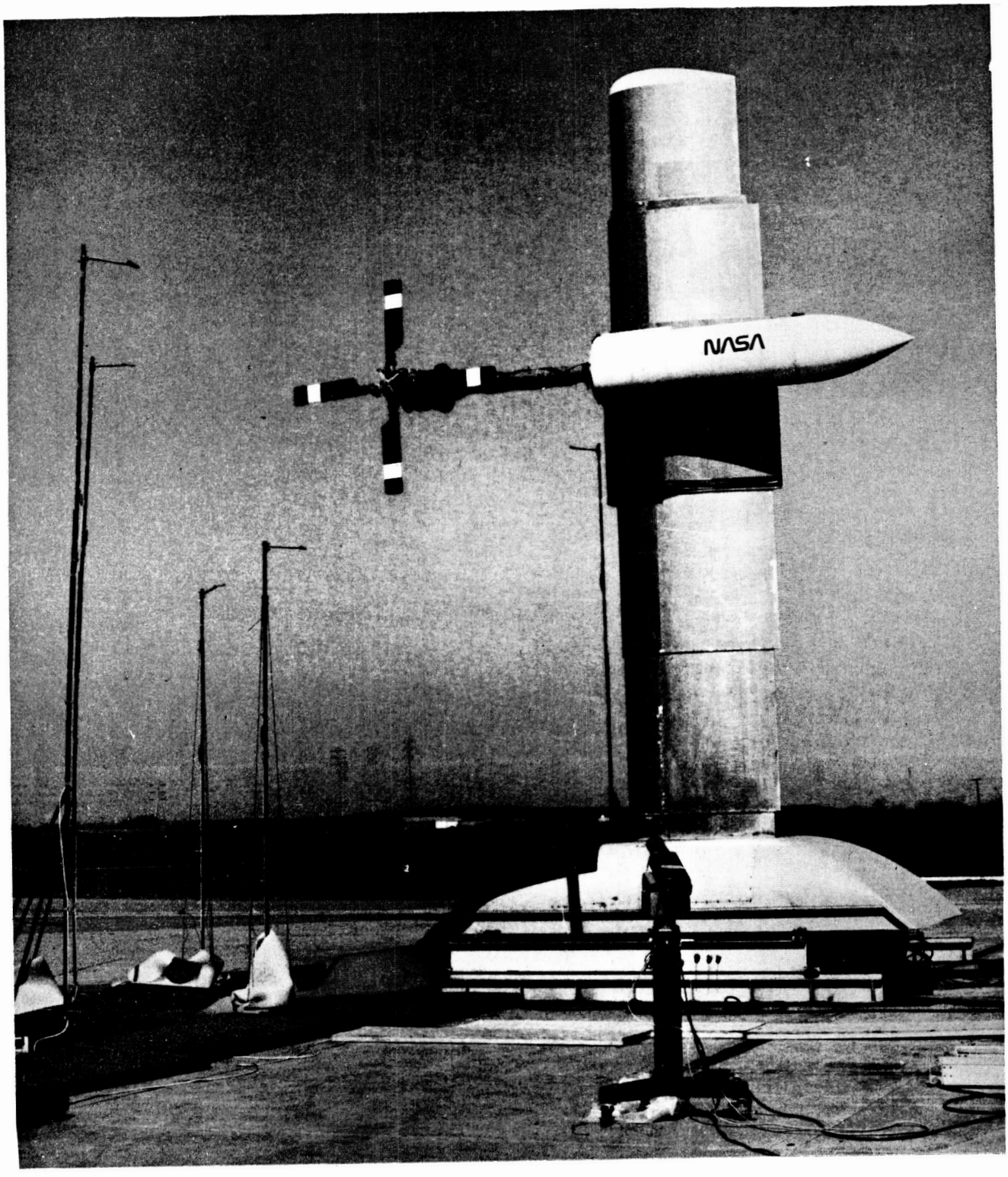

Figure 1.– Lynx tail rotor and tail rotor test rig.

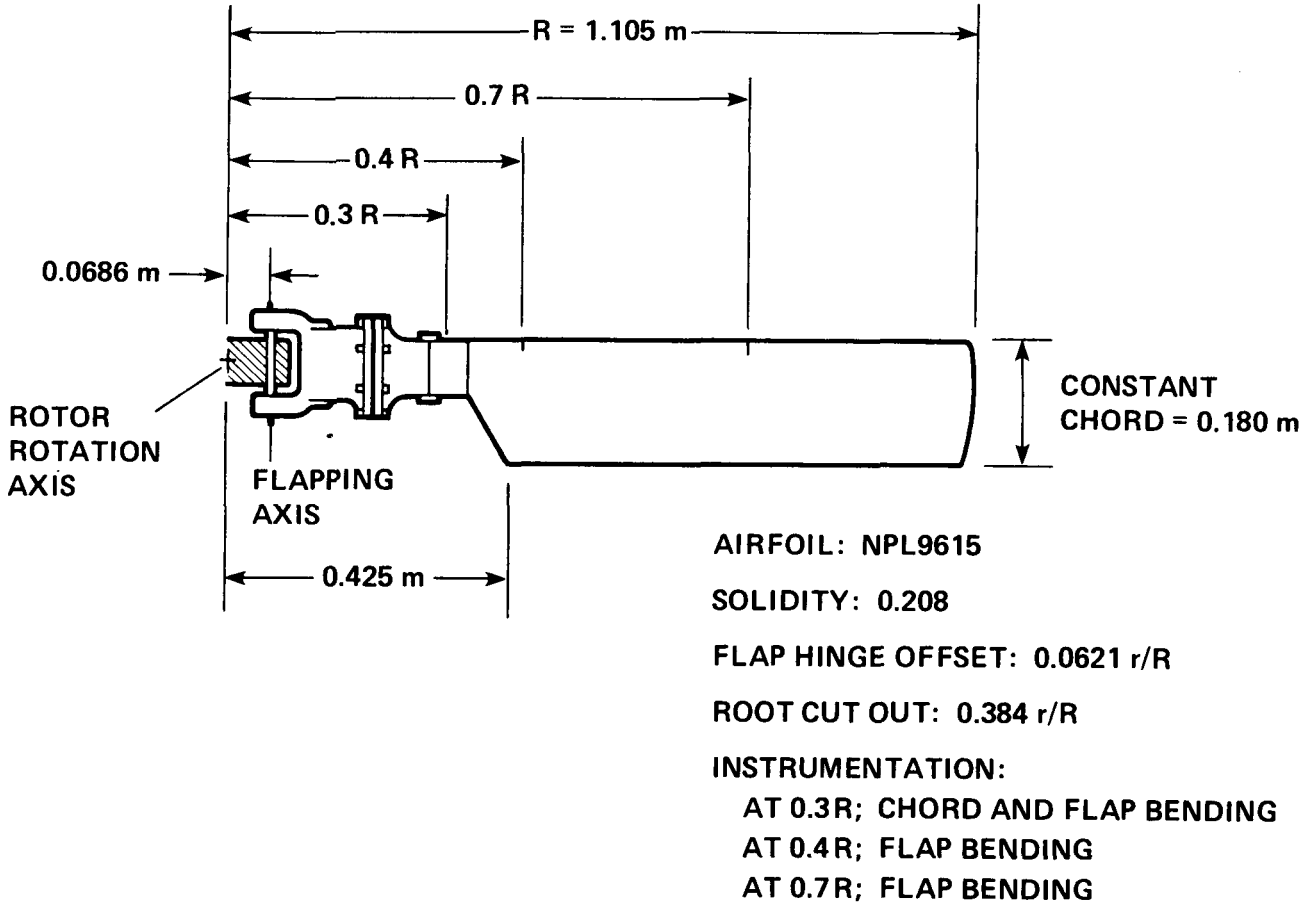

Figure 2.– Tail rotor blade.

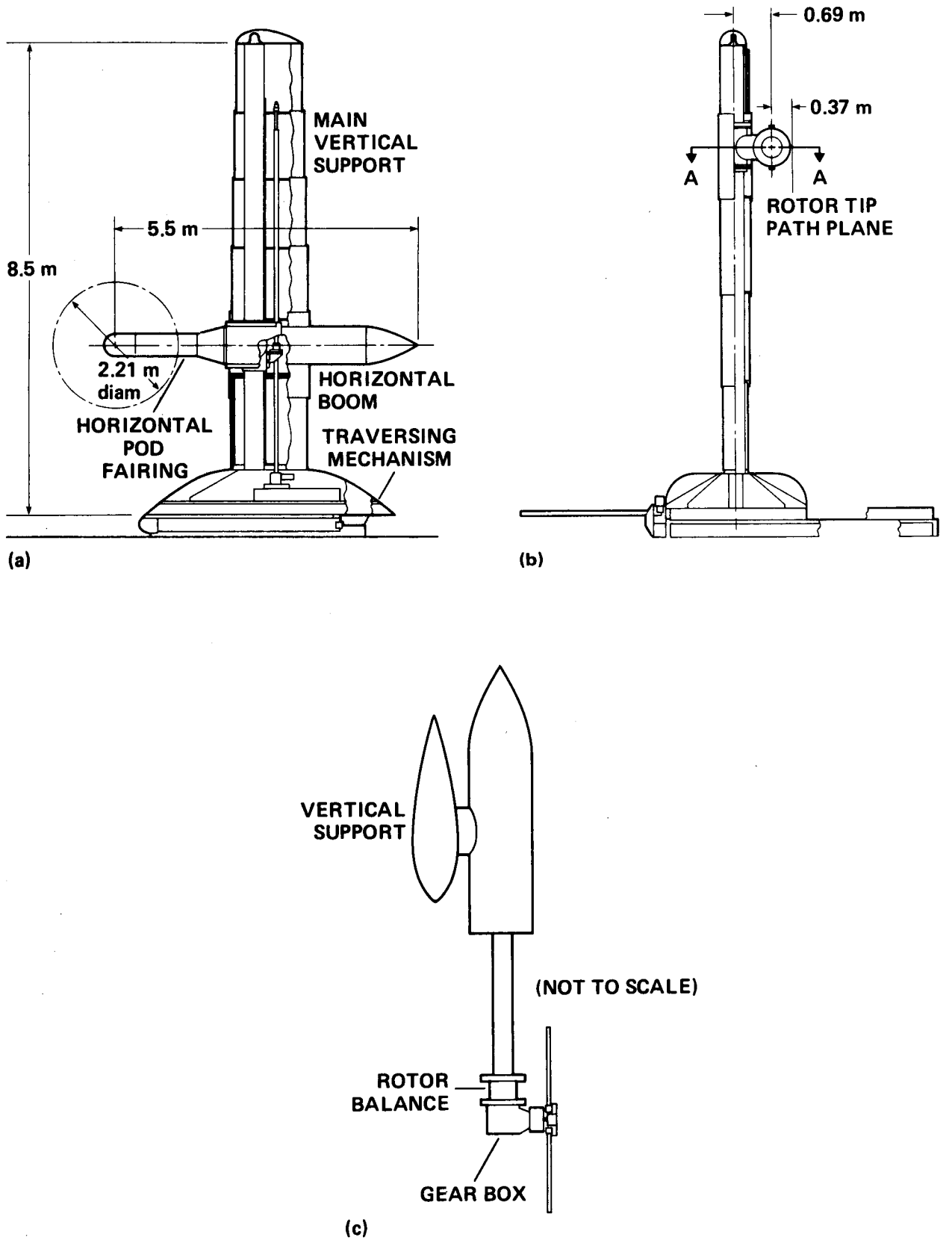

Figure 3.– Tail rotor test rig. (a) Front view, (b) side view, (c) section A-A.

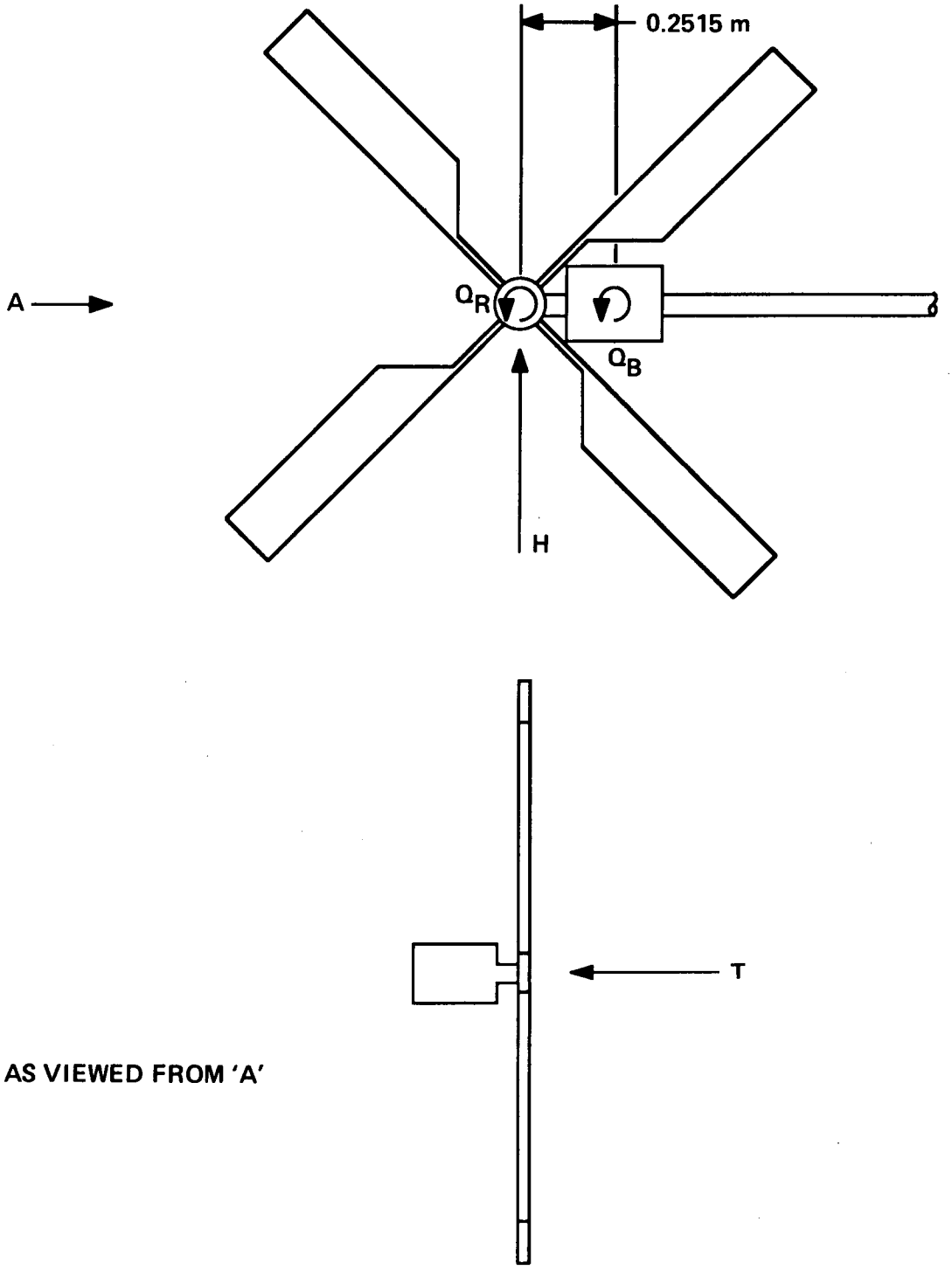

Figure 4.– Rotor balance configuration.

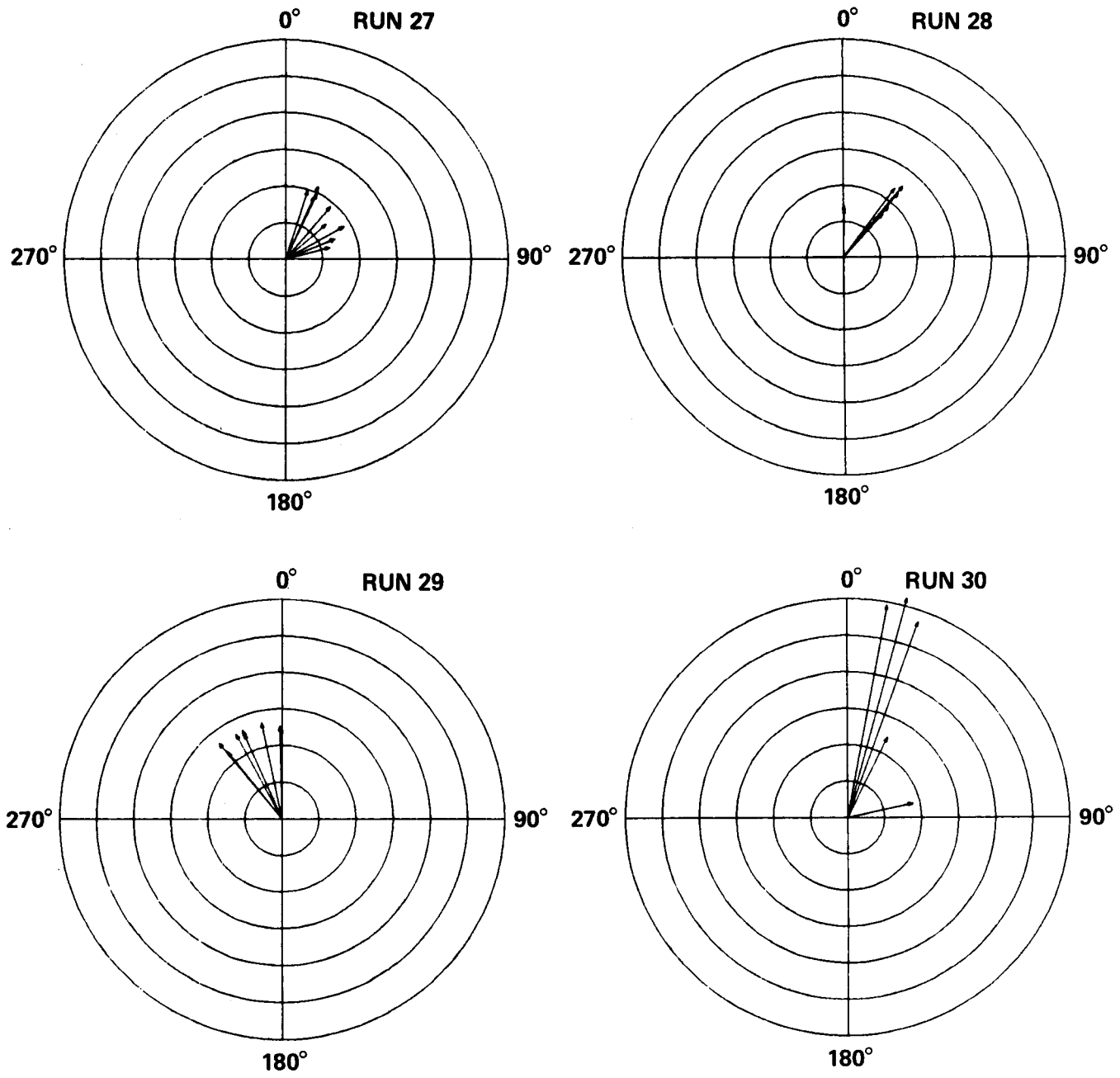

Figure 5.– Ambient wind speed and direction: Runs 27-30.

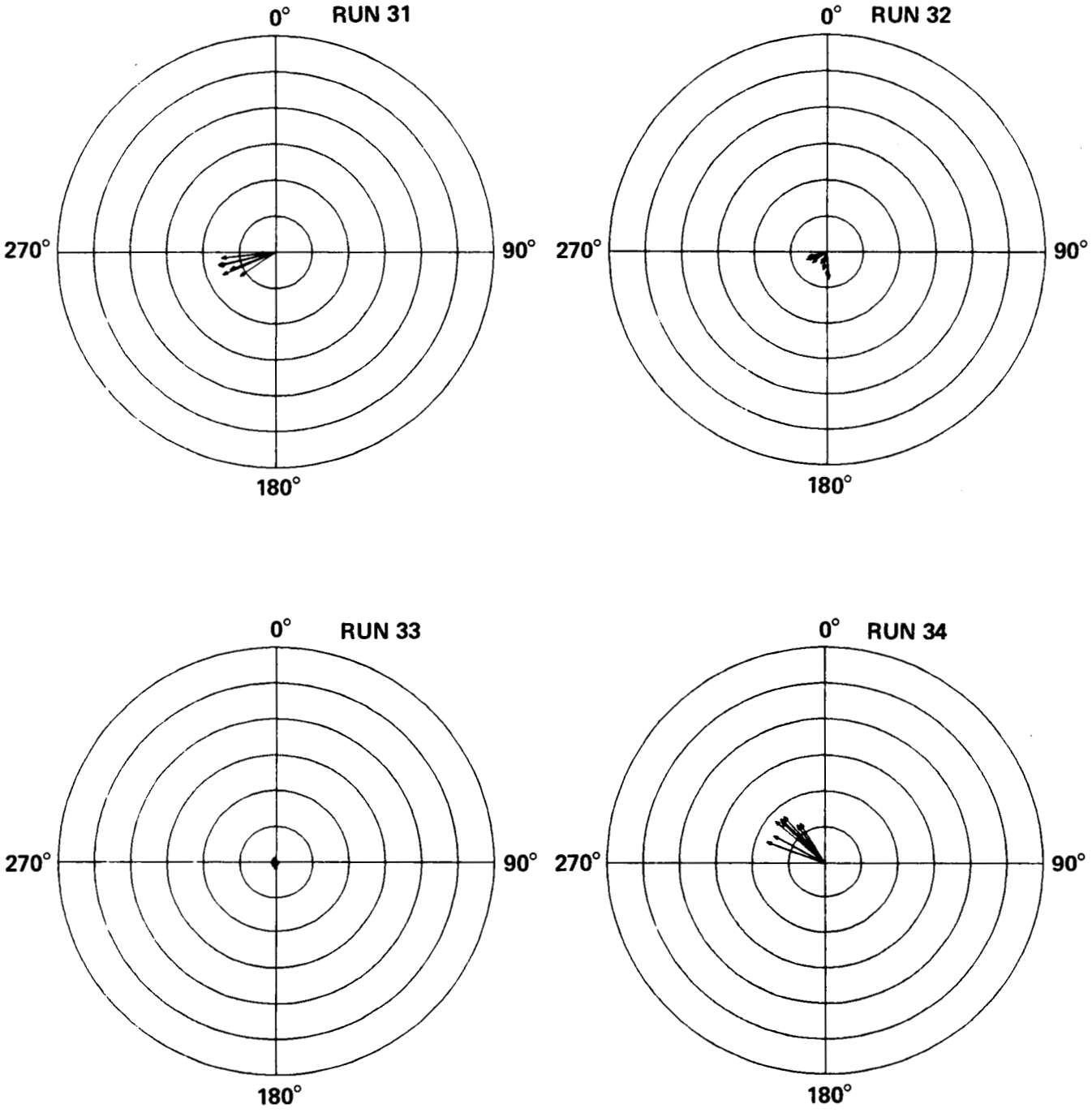

Figure 6.– Ambient wind speed and direction: Runs 31-34.

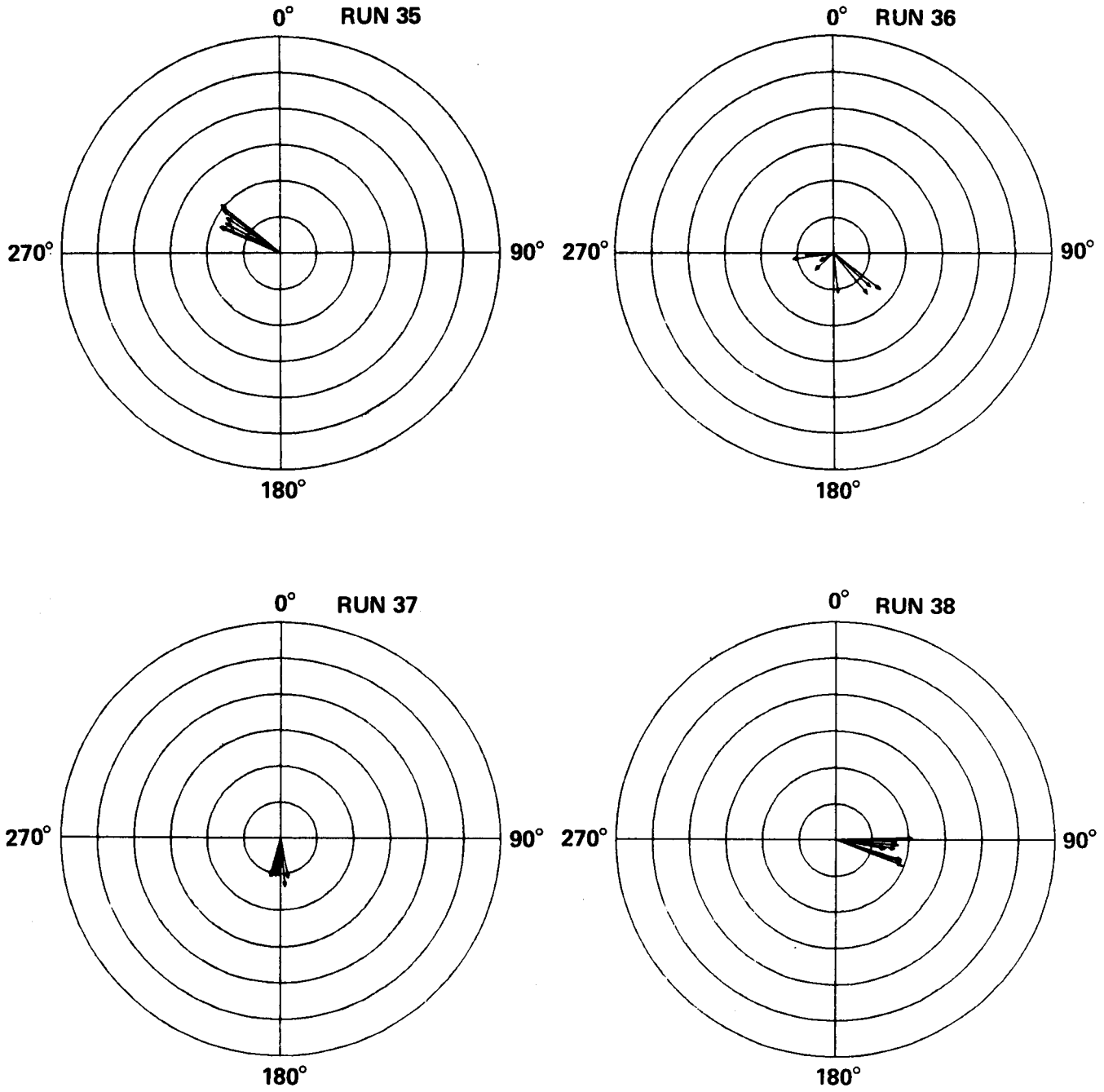

Figure 7.– Ambient wind speed and direction: Runs 35-38.

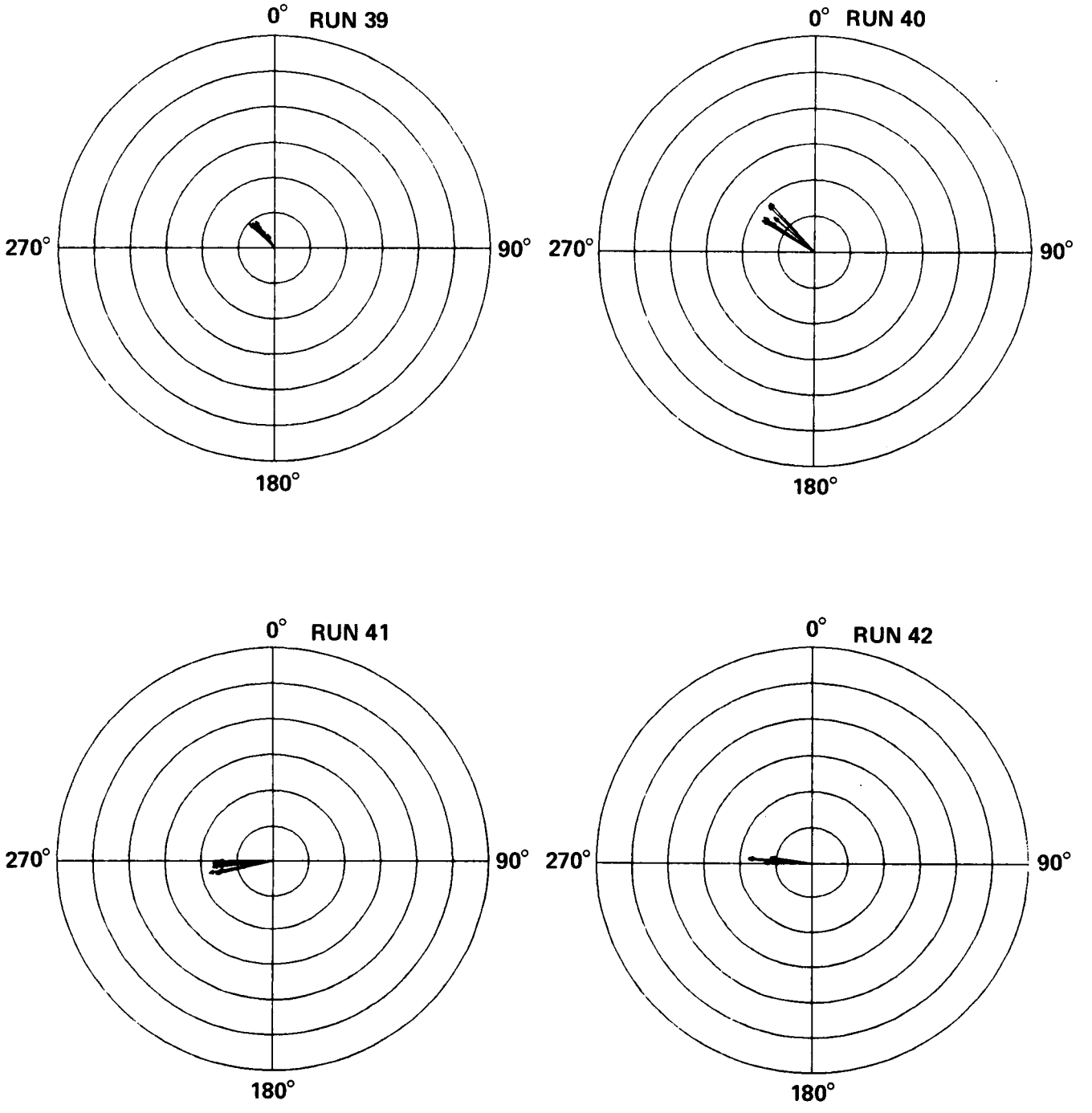

Figure 8.– Ambient wind speed and direction: Runs 39-42.

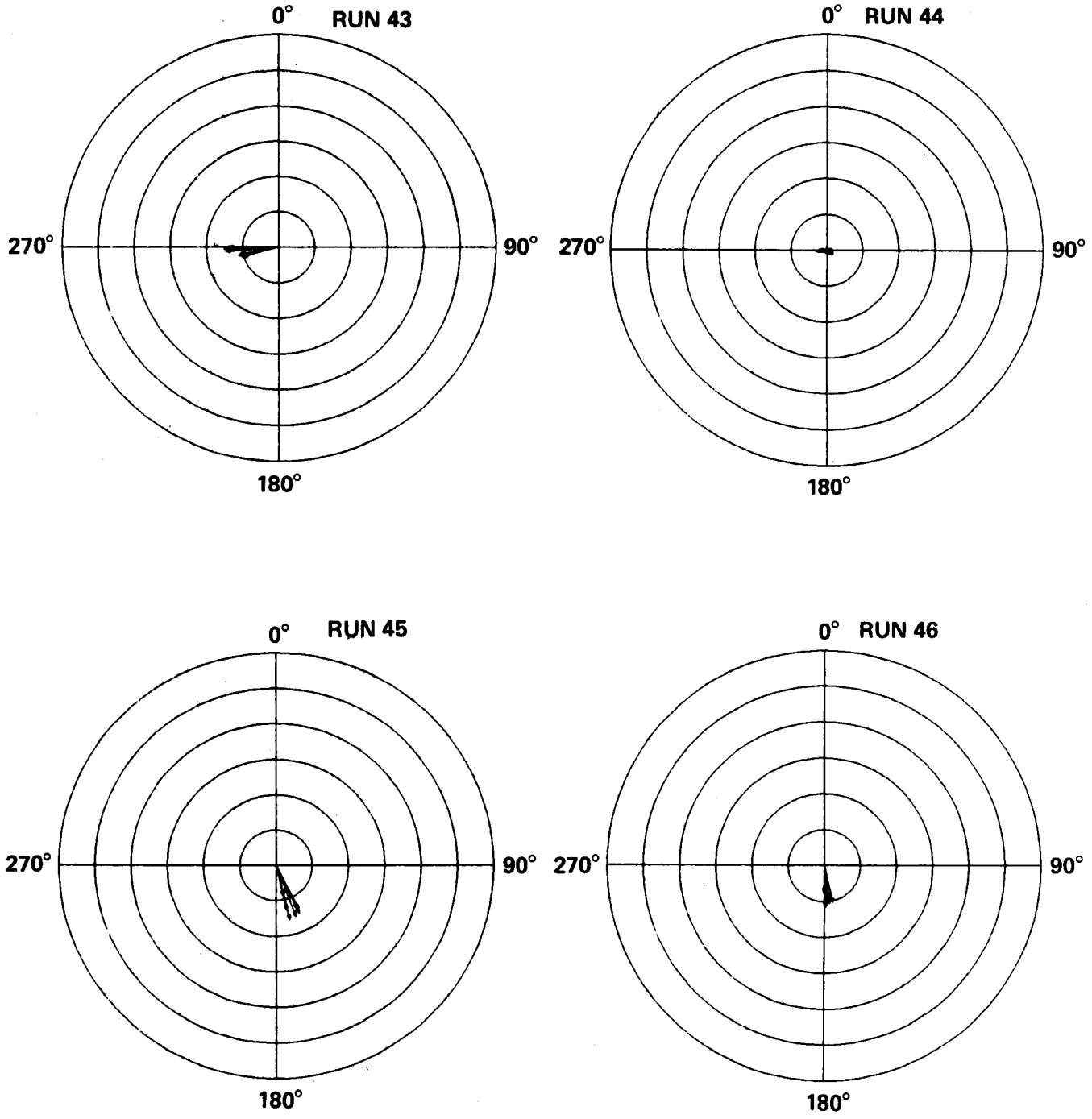

Figure 9.– Ambient wind speed and direction: Runs 43-46.

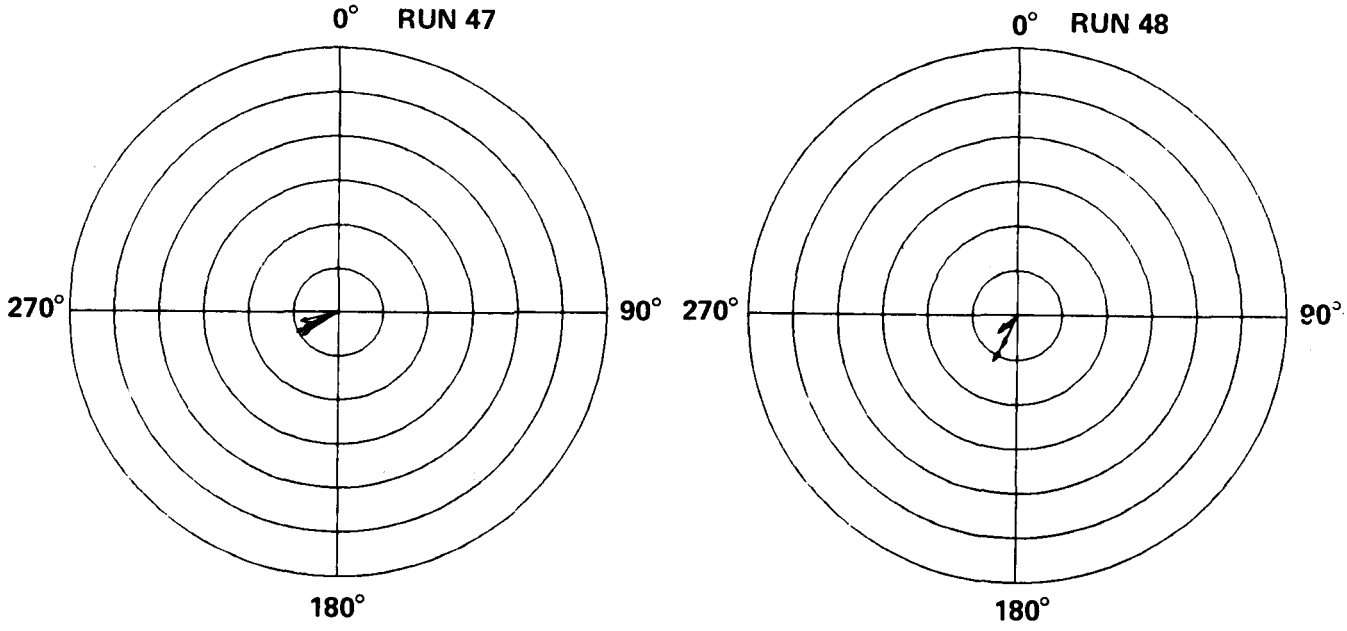

Figure 10.– Ambient wind speed and direction: Runs 47-48.

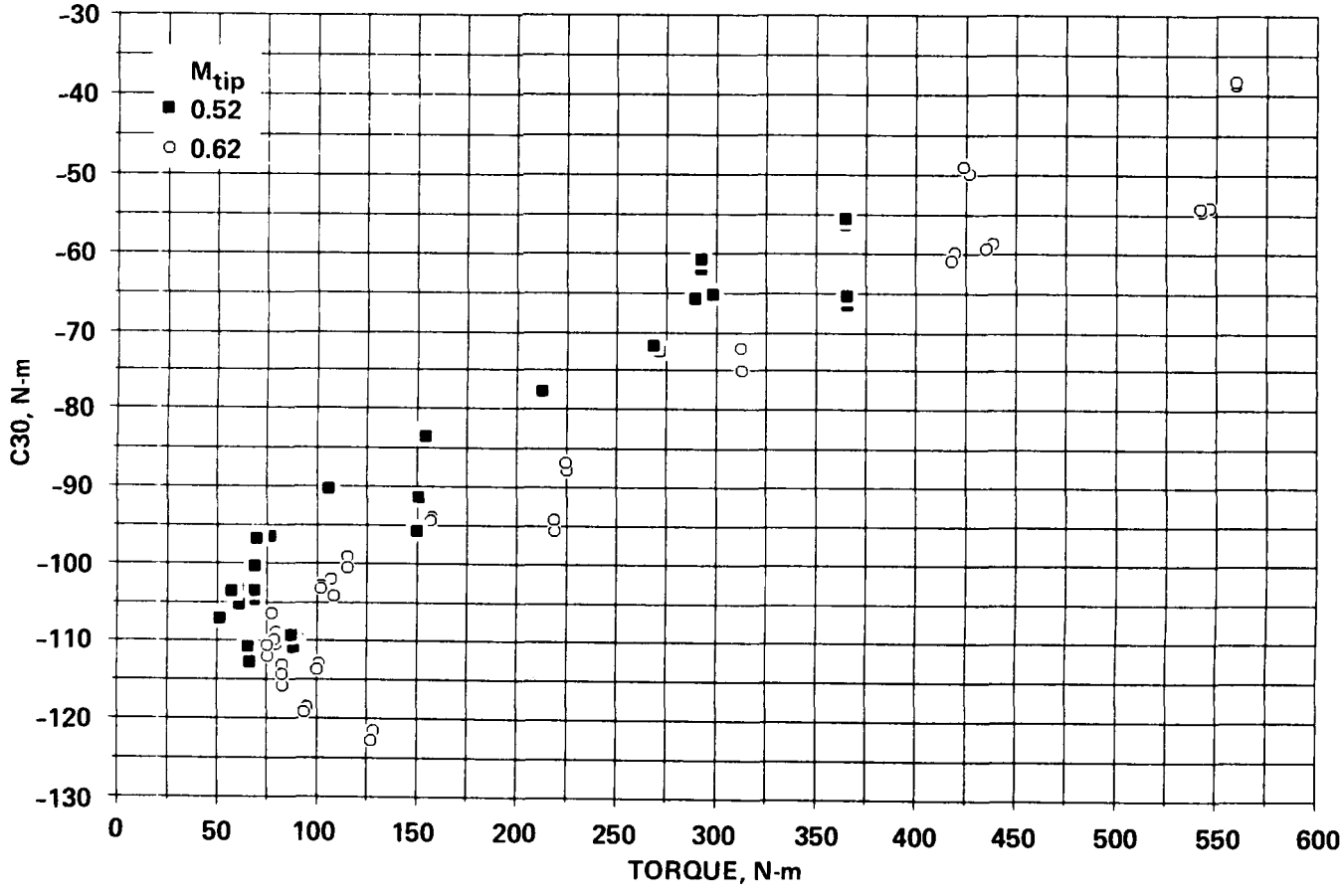

Figure 11.– Effect of rotor torque on mean chordwise bending moment – 30% R.

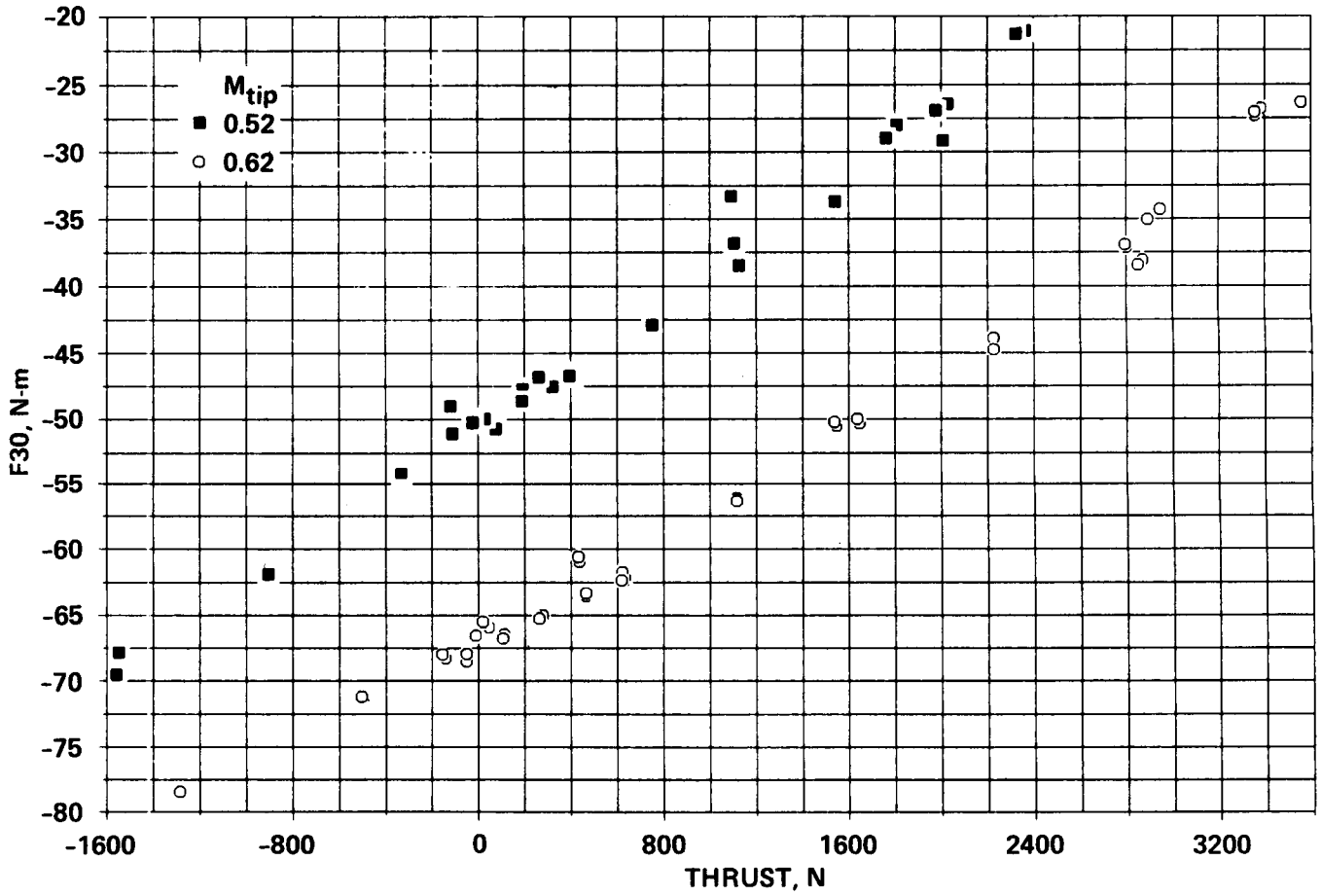

Figure 12.– Effect of rotor thrust on mean flapwise bending moment – 30% R.

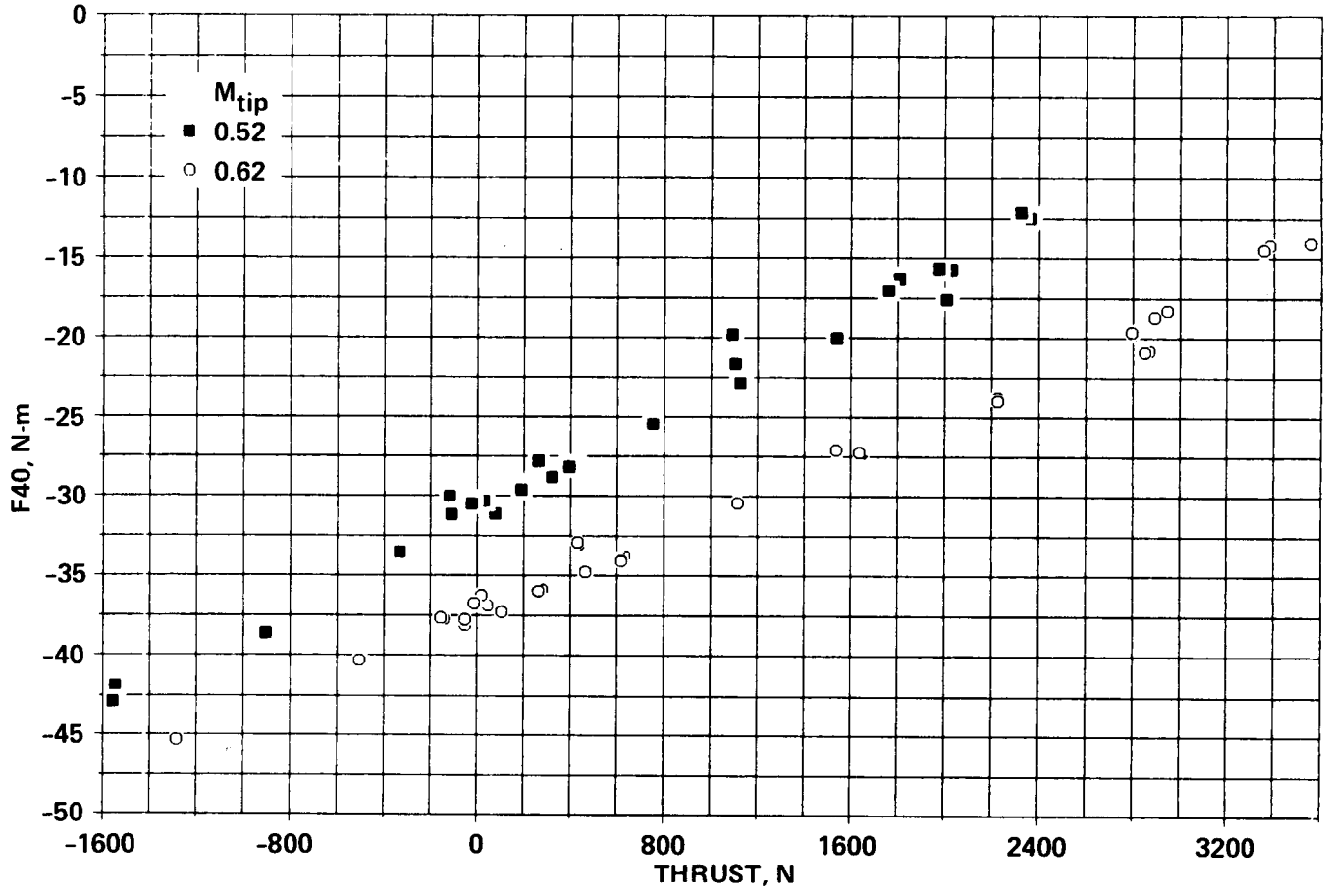

Figure 13.– Effect of rotor thrust on mean flapwise bending moment – 40% R.

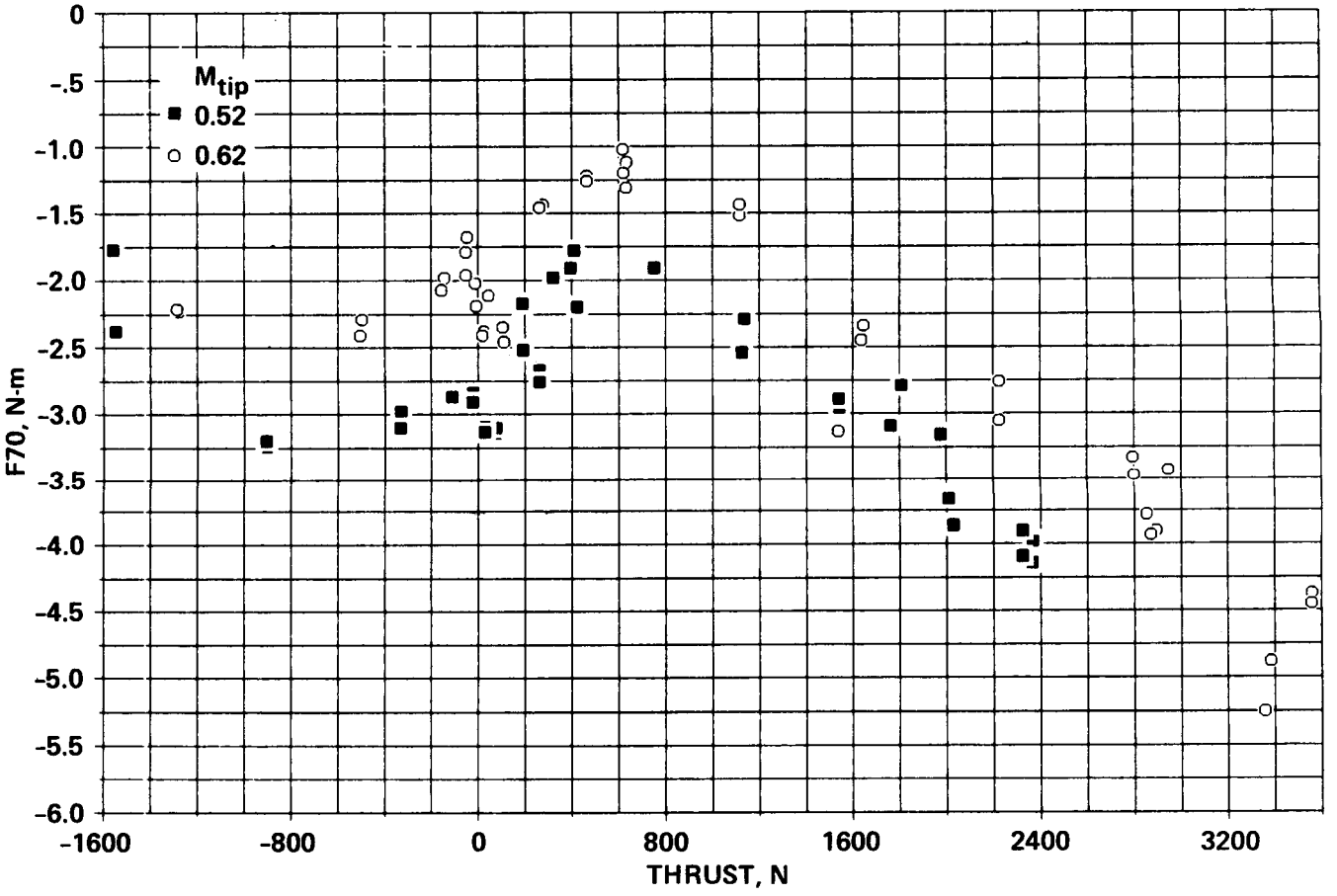

Figure 14.– Effect of rotor thrust on mean flapwise bending moment – 70% R.

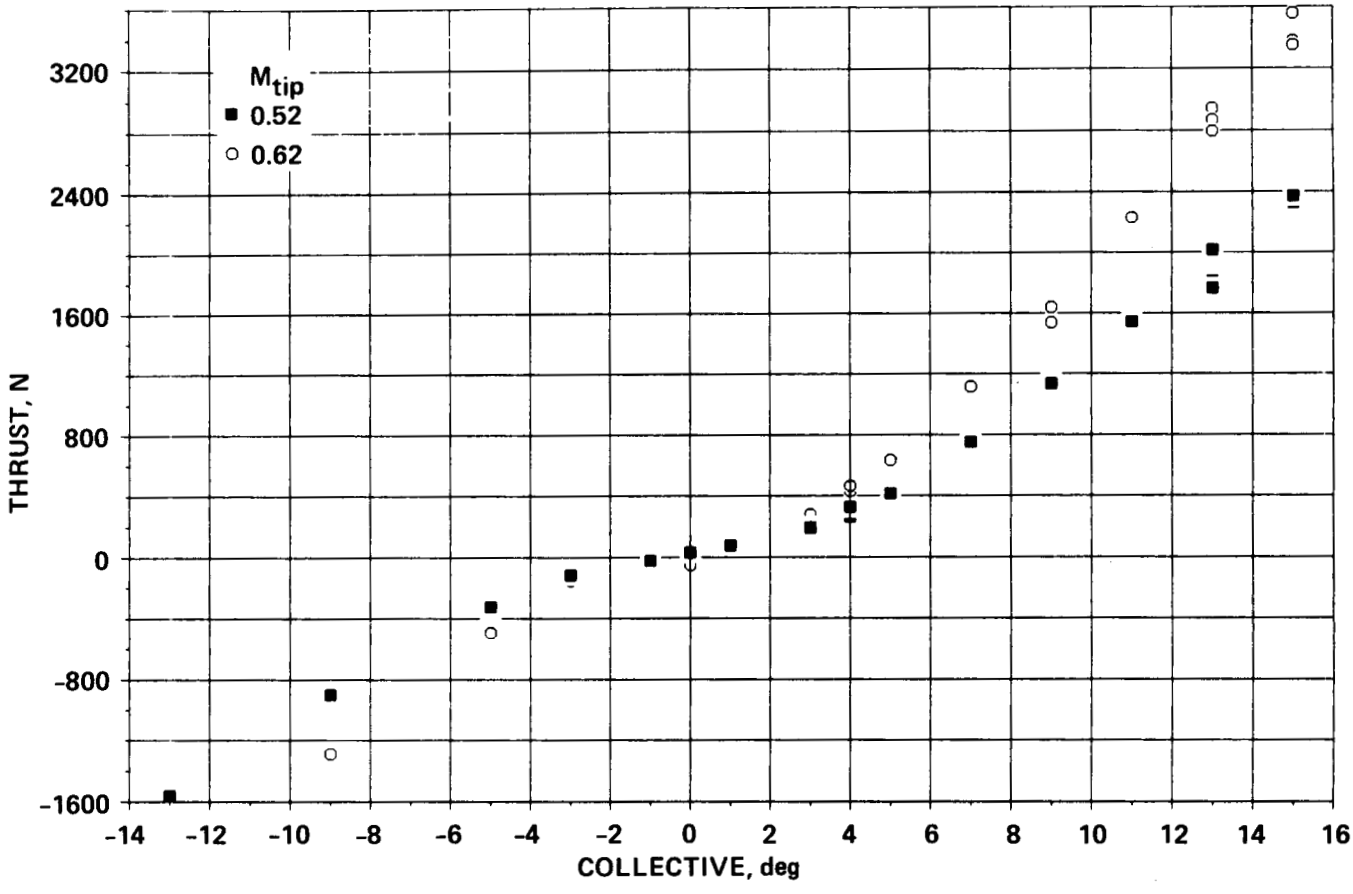

Figure 15.– Effect of collective pitch on rotor thrust.

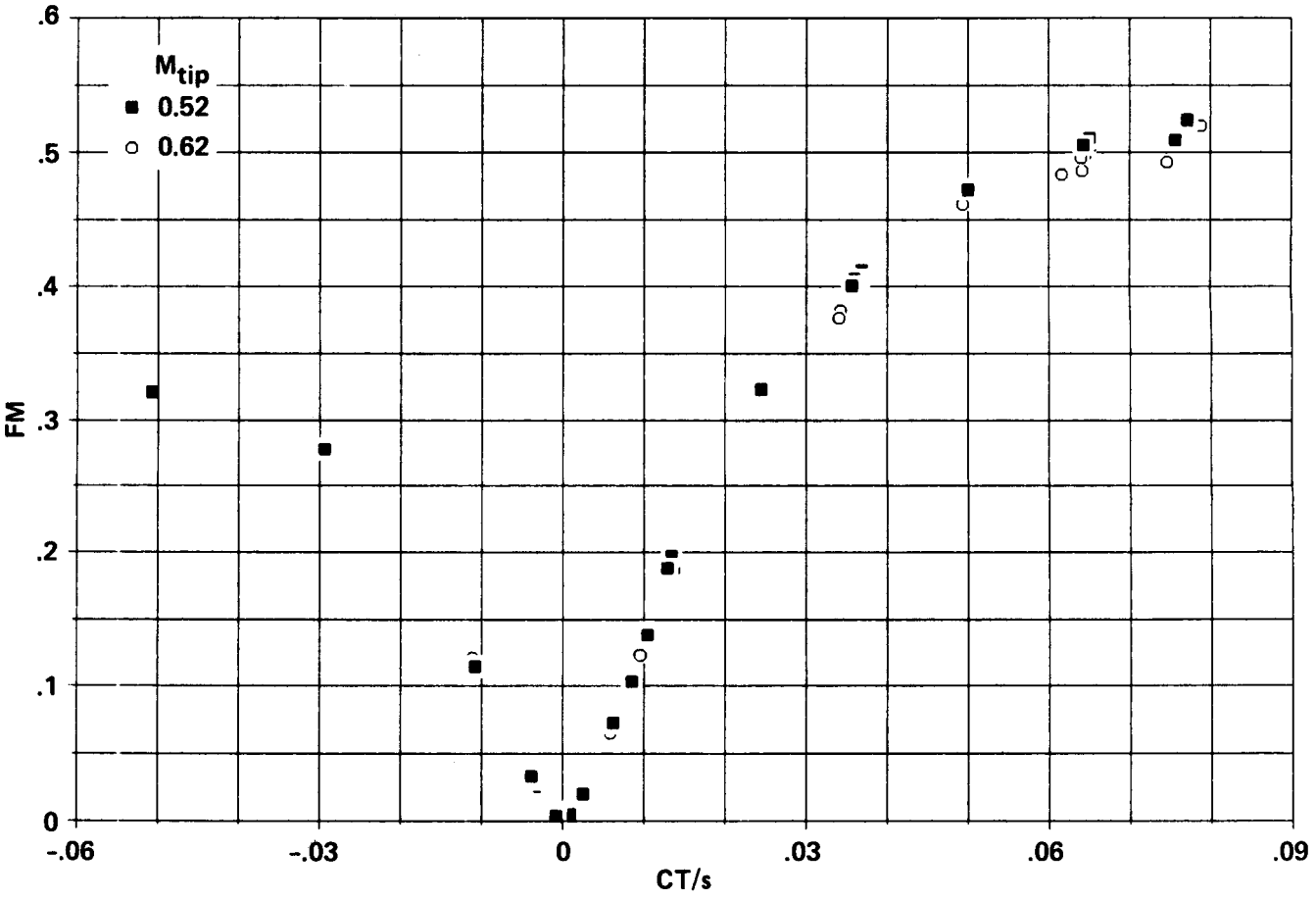

Figure 16.– Rotor figure of merit.

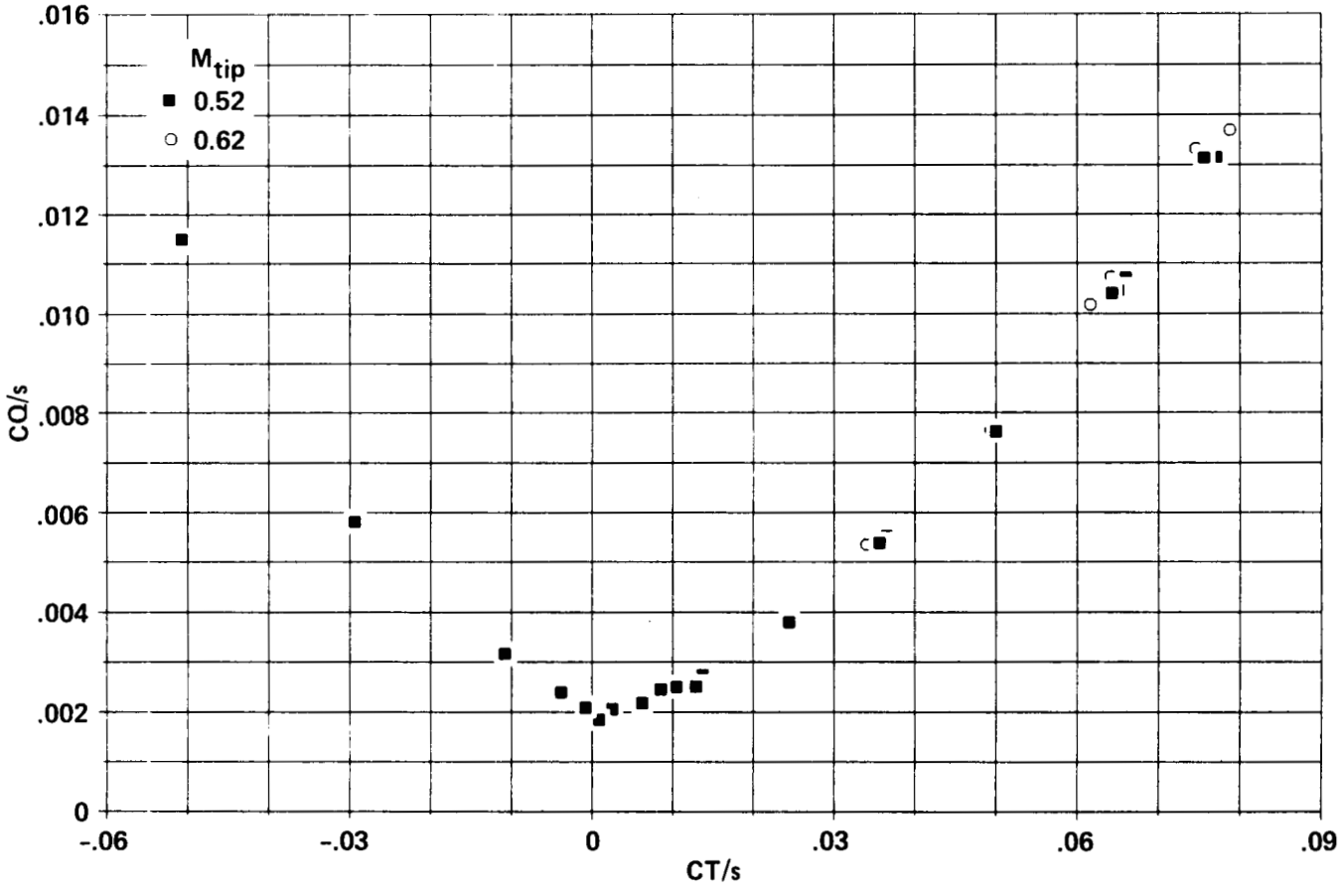

Figure 17.– Tail rotor performance C_Q/s vs. C_T/s.

NASA
National Aeronautics and Space Administration

Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA TM-101057		

4. Title and Subtitle

Performance and Loads Data from an Outdoor Hover Test of a Lynx Tail Rotor

5. Report Date
June 1989

6. Performing Organization Code

7. Author(s)

David B. Signor, Gloria K. Yamauchi, Charles A. Smith, and Martin J. Hagen

8. Performing Organization Report No.
A-89014

10. Work Unit No.
505-61-51

9. Performing Organization Name and Address
Ames Research Center
Moffett Field, CA 94035

11. Contract or Grant No.

13. Type of Report and Period Covered
Technical Memorandum

12. Sponsoring Agency Name and Address
National Aeronautics and Space Administration
Washington, DC 20546-0001

14. Sponsoring Agency Code

15. Supplementary Notes

Point of Contact: Gloria K. Yamauchi or David B. Signor, Ames Research Center, MS TR-031
Moffett Field, CA 94035 (415) 694-4682 or FTS 464-4682

16. Abstract

A Lynx tail rotor was tested in hover at the Outdoor Aerodynamic Research Facility at NASA Ames Research Center. The test objectives were (1) to measure the isolated rotor performance to provide a baseline for subsequent testing, and (2) to operate the rotor throughout the speed and collective envelope before testing in the NFAC 40- by 80-Foot Wind Tunnel. Rotor forces and blade bending moments were measured at ambient wind conditions from zero to 6.23 m/sec. The test envelope was limited to rotor speeds of 1550 to 1850 rpm and –13° to +20° of blade collective pitch. The isolated rotor performance and blade loads data are presented.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
Lynx tail rotor Rotor forces Blade loads	Unclassified-Unlimited Subject Category – 02

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of pages	22. Price
Unclassified	Unclassified	63	A04

For sale by the National Technical Information Service Springfield, Virginia 22161